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# A TEXTBOOK OF MINERALOGY



School of Archieology.

# A TEXTBOOK

OF

# MINERALOGY

WITH AN EXTENDED TREATISE ON

# CRYSTALLOGRAPHY AND PHYSICAL MINERALOGY



EDWARD SALISBURY DANA

Late Professor Emeritus of Physics, Yale University

POURTH EDITION, REVISED AND ENLARGED

IIY

# WILLIAM E. FORD

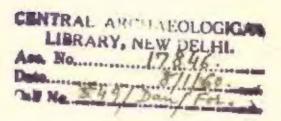
Late Professor of Monocology and Curater of the Mineral Collections, Sheffeld Scientific School of Yals University

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First Indian Edition: 1959

# PREFACE TO THE FOURTH EDITION

It is only a little over ten years since the third edition of this book was published. This period, however, has been one of such active mineralogical investigation that a new edition seemed desirable. The fourth edition, therefore, endeavors to present the important facts of the science as known on January 1, 1932. The changes in the book are essentially as follows: In Part I on Crystallography a section of some seventeen pages has been added on crystal structure and the methods of its investigation by means The remainder of this section remains substantially unchanged. Parts II and III on Physical and Chemical Mineralogy have been revised but have had only minor additions. "Part IV on the Origin, Mode of Occurrence and Association of Minerals is new to this book. Part V has been entirely revised. Descriptions of about two hundred and twenty new species have been added. The attempt has been made to give a brief but complete statement of the important facts now known about all well-defined mineral species. In addition brief mention is made of doubtful species or those which have recently been discredited. It is realized that such a complete treatment of the subject would not normally have its place in a book of this character. At the present time, however, there is no book available that gives such a survey of the subject and until such a book is at hand it is thought that the inclusion here of brief descriptions of all known minerals will be of value. As far as possible simple statements of the results of the investigation of mineral structure by means of X-rays have been included in the mineral descriptions. The paragraphs on occurrence have been largely rewritten. In the case of the commoner minerals a careful selection of the localities of their occurrence has been made in order to give only those of most importance either from a scientific or economic point of view. In the case of rarer species all known localities have been mentioned. As far as possible the locality names have been checked, the spelling used by the Times Atlas having been followed in most instances. In the case of the south-central European countries, alternative names for the same place have been frequently given.

The mineral data presented have been gathered from the periodical literature, etc., and from many texts. Among the books which have been of particular value are the following: Doelter's Handbuch der Mineralchemie, Hintze's Handbuch der Mineralogie, Lehrbuch der Mineralogie by Niggii, Mineralogy by Miers-Bowman, and especially Winobell's Elements of Optical Mineralogy and Larsen's Microscopic Determination of the Nonopaque Minerals. The editor is also indebted to Professor Esper S. Larsen for the privilege of consulting the manuscript of the new edition of the last-named work. He also acknowledges gratefully many valuable suggestions made

by Professor Charles Palache.

WILLIAM E. FORD

# PREFACE TO THE THIRD EDITION

The first edition of this book appeared in 1877 and approximately twenty years later (1898) the second and revised edition was published. Now, again after more than twenty years, comes the third edition. The changes involved in the present edition are chiefly those of addition, the general character and form of the book having been retained unchanged. In the section on Crystallography the important change consists in the introduction of the methods employed in the use of the stereographic and gnomenic projections. A considerable portion of the section on the Optical Characters of Minerals has been rewritten in the endeavor to make this portion of the book simpler and more readily understood by the student. In the section on Descriptive Mineralogy all species described since the previous edition have been briefly mentioned in their proper places. Numerous other changes and corrections have, of course, been made in order to embody the results of mineral investigation during the last two decades. Only minor changes have been made in the order of classification of the mineral species. It was felt that as this book is so closely related to the System of Mineralogy it was unwise to attempt any revision of the chemical classification until a new edition of that work should appear. The description of the methods of Crystal Drawing given in Appendix A has been largely rewritten. A new table has been added to Appendix B in which the minerals have been grouped into lists according to their important basic elements. Throughout the book the endeavor has been to present in a clear and concise way all the information needed by the elementary and advanced student of the science.

The editor of this edition is indebted especially to the published and unpublished writings of the late Professor Samuel L. Penfield for much material and many figures that have been used in the sections on Crystallography and The Optical Character of Minerals. He also acknowledges the cordial support and constant assistance given him by Professor Edward S.

Dana.

WILLIAM E FORD

Naw Haven, Court, Dec. 1, 1921

# PREFACE TO THE SECOND EDITION

The remarkable advance in the Science of Mineralogy, during the years that have elapsed since this Text-Book was first issued in 1877, has made it necessary, in the preparation of a new edition, to rewrite the whole as well as to add much new matter and many new illustrations.

The work being designed chiefly to meet the wants of class or private instruction, this object has at once determined the choice of topics discussed,

the order and fullness of treatment and the method of presentation.

In the chapter on Crystallography, the different types of crystal forms are described under the now accepted thirty-two groups classed according to their symmetry. The names given to these groups are based, so far as possible, upon the characteristic form of each, and are intended also to suggest the terms formerly applied in accordance with the principles of hemibedrism. The order adopted is that which alone seems suited to the demands of the elementary student, the special and mathematically simple groups of the isometric system being described first. Especial prominence is given to the " normal group " under the successive systems, that is, to the group which is relatively of most common occurrence and which shows the highest degree of symmetry. The methods of Miller are followed as regards the indices of the different forms and the mathematical calculations.

In the chapters on Physical and Chemical Mineralogy, the plan of the former edition is retained of presenting somewhat fully the elementary principles of the science upon which the mineral characters depend; this is particularly true in the department of Optics. The effort has been made to give the student the means of becoming practically familiar with all the modern methods of investigation now commenly applied. Especial attention is, therefore, given to the optical properties of crystals as revealed by the microscope. Further, frequent references are introduced to important papers on the different subjects discussed, in order to direct the student's attention to

the original literature.

The Descriptive part of the volume is essentially an abridgment of the Sixth Edition of Dana's System of Mineralogy, prepared by the author (1892). To this work (and future Appendices) the student is, therefore, referred for fuller descriptions of the crystallographic and optical properties of species, for analyses, lists of localities, etc.; also for the authorities for data here quoted. In certain directions, however, the work has been expanded when the interests of the student have seemed to demand it; for example, in the statement of the characters of the various isomorphous groups. Attention is also called to the paragraph headed "Din.," in the description of each common species, in which are given the distinguishing characters, particularly those which serve to separate it from other species with which it might be easily confounded.

The list of American localities of minerals, which appeared as an Appendix in the earlier edition, has been omitted, since in its present expanded form

it requires more space than could well be given to it, farther, its reproduction here is nanecessary since it is accessed to to all in orespect not only in the System of Mireralogy but also in separate form. A full topical linter has

been ad lea, begues the usual Index of Species

The oraginaries of the present to burne to well-known works of other authere partied any to the of tiroth and Rosenbusch - are too obvious to require special mention. The nuttor must be wever express his gratifiede to his colleague, Prof. L. V. Pirsson, who has given hen material art in the part of the wirk deshing with the optical properties of numerals as examined under the microscope. He is now indeffect to Prof S. L. Penfield of New Haven no i to Prof. H. A. Miers of Oxford Linguard, for various valuable BURREN ATTAL

EDWARD SALIBBURY DANA

NEW HAVEN, CORN., Aug. 1, 1808.

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### INTRODUCTION

1. The Science of Mineralogy treats of those inorganic species called minerals with together in rock masses or in so afed form make up the insternal of the crust of the earth, and of other bodies in the mineral as it is possible to set is them in the form of mercorites

 Definition of a Mineral. - A Mineral is a budy produced by the proceries of inorganic nature, having urnally a definite chemical composition and if formed under favorable vo. d. trong, a certain characteristic atomic structure which

M expressed in the eristadine form and other physical properties

This definition colls for some further explanation

I est of all, a mercal must be a homogeneous substance, even when entenues examined by the microscope further, it must have a chemical composition which commonly is teleste and can be expressed by a chemical formula. In some cases the chamical emposition is various but only within certain hunts and then usually according to a definite law. Thus, much buselt appears to be homogeneous to the eye, but when examined under the narrow person this sections it is seen to be under up of different substances, each anche glassecters of its own. Again, obsiding, or vicinity glass, though it may be essentianly from igeneous, has not a sufficiently definite composition to be classed as a trueful.

Age of a namery basin most cases a definite atomic structure. This atomic structure, as will be shown later, townsfests itself in the physical characters and expecially in the external crystal for form. A numeral, in the majority of cases, possesses both general properties, such as composition, specific granty metting point, etc. and directional properties, such as its atomic structure er, and symmetry epical characters, etc. The combination of

these , we kinds of characters serves to define a manera species

It is customary, as a matter of convenience to and, the name inneral to those companies which have been formed by the processes of nature alone, whereas companies under a the laboratory or the sine ong furnace are at best called artificial innerals. Further, it total substances which have been prochased through the squarcy of organic afe are not included aroung innerals, as the pearly fan oye or one. Finally, inneral species are, as a rule, himself to solid estatances, the only argueds included being metalac increasing rather of peveral by precarled, compounds in the honce not a inneral species.

It is obvious from the above that minerals, in the somewhat restricted sense usually adopted, constitute only a part of what is often called the

Maneral Kingdom.

3. Scope of Mineralogy In the following pages, the general subject

of immeral say is treated and if the following heads

1 (rystategraphy - This comprises a discussion of crystals in general and especially of the crystalane forms of inneral species.

(2) Physical Mineralogy - This includes a discussion of the physical characters of minerals, they is those depending upon cohesion and clasticity,

density light, heat, a cerricity, and so on

3 Chemes, Minera gy Under his head are presented briefly the general point ples of clematry as applied to material species. Their characters as changed compounds are described also the methods of investigating them from the homical size by the blowpope an aller a rans

(1) Occurrence of Monerals This section includes a price description of the different modes of mineral occurrence, characteristic miners, associa-

tions, etc.

5. Descriptor Moneralogy - This includes the classification of minerals and the description of each species with the varieties respectfully in its relations to charly adice, species as regards crystall as form physical and chargeal

characters, occurrence a patare and other beints.

4. Literature. Reference is made to the Introduction to the Sixth Ed. on of Pasa's Sys on of Mineralogy, pp. gry 30, for an extended did of in epen lent works an Marralogy up to 1802 and to its Appendics I, II and HI for works pulcashed up to 1915, the naties are also given of he tentry securific perior, his which continuouspeal maps one on an aerological subjects. For the convenience of the student the titles I a few works, most y of a general character, are given here. I in her references to the steral see of M actuagy are introduced through the first half of this work. particularly at the end of a sections dealing with special subjects.

#### Crystallography and Physical Menerglogy

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The wints A is used to indicate the single between two faces of a crystal, as an (100 A 110) 44" J0.



# PART I. CRYSTALLOGRAPHY

# GENERAL MORPHOLOGICAL RELATIONS OF CRYSTALS

6. Crystallography. The sal per of Crystallography includes the description of the characters of crystals and their interval or atomic structure, of the various forces of crystals and their is such this chasses at a cystalia, of the me back of structure, crystals, medicing be determination of the mathema calculations of the mathema calculations of the mathematical telephones of the mathematical telephones of the mathematical telephones, a description of compound of the (crystals, of regularities in crystals) of crystal me aggregates and of pseudoparphone crystals.

6. Definition of a Crystal. A crystal is the regular positioning form, bounded by muonth surfaces which is assumed by a chemical compound under the govern of its interestimal forces, hen pursual, under suitable conditions,

from the state of a liquid or new to that of a sound

As expressed as he foregoing definition, a creat the characterized, first, by its definite internal structure had, second, by an expendition. A crystal is the narroal form of a timeral species as of all sight element compounds but the coal has suntial for the format, not a crystal of ideal perfection is symmetry of form and amountainess of surface are never fully realized but her, maintainess usually occur not in coal not crystals but in massive form and an some exceptional cases the definite internal structure as a section.

Three terms are sometimes used to as unto the literal states is which is created by superfections of the contract of the contr

7 Molecular Structure in General.— By definite molecular structure is meant the special armagement which the structural class as one of the fire section of the forces exerted activities there about given in a later article up 25 of sequential and regard to the kinds of structure, arrangement theore reads possible and near relation to the symmetry of the affects, assume and classes of cross is

The define conternal structure is the essential character of a crystal, and the external firm is only be of the wave, although an inost in scream, in which this structure is manifested. This it is found that a sum at directions in a crystal, in a fragment of a crystal, have see passess characters.

"In the original rate fleation he term expect was applies only to grystale of quarta, which the stoward a computers benevest to be some computed by intense case. Hence the learn, from spectrolibes, see

the stress of the proposition in true, vis., that make accessus is a cresse ture in proposition in true, vis., that make accessus is a cresses ture in general names accessus.

as of ematicity cohesion, action on light, etc. This is clearly shown by the clearlyse, or not its tention to fracture in certain directions, yielding more or essential theories as the cable occasing of gibens or the month-hodral clearing of calcute. It is explicit therefore that a small crimial differs from a large one only in size, and that a fragment of a cristial is testificationally a cristial in the physical resistant. The lags of swing to cristally no laces

but her, the external form with all the corresponding all countries does not make a crystal of a st., if A model of gass of wood is obviously not a crystal, the igh having the external form because there is no read on between term and structure. Asset, no or ancoron of makes one having the form of the crystal of caprate form which it has both derived by choiceal alteration is not a crystal of makes to, but what is known as a pseudomorph (see Art. 491 of makes), to after countries.

On the other hand, I the not iral external faces are wanting the sold is not called a crystal. A cleavage not about in of the rite and a cleavage rhome-boundaries of rail the are not properly crystals because the surfaces have seen you sed by fracture and not by the muture there exists growth of the crystal.

8. Crystalline and Amorphous. When a natural stews po external crystalline form it is easy to be made so. It may, however have a definite in fection strict or and then the season to be crystalline. It has not are as shown by the charage of by option to make in the same in all partial carees to the dip option to the same in all partial carees to the dip option or bier to hear, it is said to a strongenial and appropriate, annex it is it fact to the dip of a partial to the same in the

This is a grap continues of graphs of colors of may be possible to separate the frequency from the hard of each with its characteristic color of the relationship to be before over age. Investigate the residual of a separate of vertile colors go and hence the residual of the frequency loss of a fresh to roke to a fee the region of the agent may there it is a separate of the paper, the agency of sire to make the with the paper of the macroscope. It is all these coses, the structure is such to be created from

Ste introductively has shown that more the a 95 per cent of numerola class definite crystalline we are re-

If optical means show a more or less distance restal are structure, which, however, cannot be resolved and in the distance of seasons and to be crypto-crustalized time a true of some massive various of papers.

If the definite in secolar structure event it is not the and all directions in the mass are woughts the same the either it is a said to be amorphous. This is true if a piece of gains, and nearly so if spal. The amorphous state is rare among numerous.

A piece of for topics which has been fixed and covered suit tents may be in the grand-like amorph and cuts to be regarded as a second of the covered as the Brown of the back of the best of the back of the back of the back of the property of the back of the property of the back of t

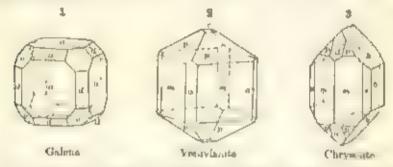
<sup>\*</sup> The consideration of he various forms of crystianne aggregates is postponed to the end of the present chapter

The minroscopic study of rocks reveals many cases in which an abilingual change in the ere at structure has taken place in a acid mass, as caused, for example, by great

 External Form. — A crystal is bounded by smooth plane surfaces, called faces or planes," showing in their arrai gement a certain characteristic

symmetry and related to each other by definite mathematical laws.

Thus, without inquaring, at the moment, into the exact meaning of the term symmetry as applied to crystals, and for kinds of symmetry possible, which will be explained in detail later, it is apparent that the accompanying figures, 1.3 show the external form spoken of. They represent, therefore, certain definite types



10. Variation of Form and Surface Actual crystals deviate, within

certain lim s, from the cleal forms.

First, there may be variation in the size of fixe faces, thus producing what are defined later as distorted forms—In the second prace, the faces are tracily absolutely smooth and brilliant, commody they back perfect point, and they may even be reagh or in its or less covered a theface parallel ones (ended striations, or above minute elevations, depressions or other pecuations, Both the above supports are discussed in detail in another place.

It may be noted in passing that the characters of initinal faces just to uded to, in general cause it easy to distinguish between them and a face artificially ground on the one has t, like the facet of a cut gent, or, on the other hand, the spiritery

tureven surface ectam r ly yie led by cleavage.

11. Constancy of the Interfacial Angles in the Same Species. — I in angles of inclination between like faces on the creatals of any species are essentially constant wherever they are found, and whether products of nature or of the laboratory. These angles, therefore, form one of the important distinguishing characters of a species.

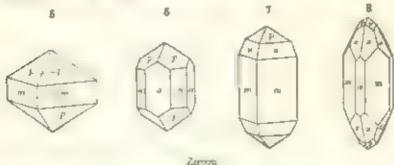
This, in Fig. 4, of apatite, the angle between the adjacent faces x and m 130° 18') is the same for any two ske faces, and structed with reference to each other. Further, this angle is constant for the species no matter what the size of the crystal may be or from what local ty it may come. Moreover, the angles between all the faces on

The latter word is usually limited to cases where the direction, rather than the definite surface Healf, is designated.

crystals of the same species of Egs 5 S of arcen below) are more or less

close's connected by cor ain a fewer mattern at our laws.

12. Diversity of Form, or Habit. While in the crystals of a given species there is constancy of angle between like these their rise of the crystals may be exceedingly diverse. The accompanying figures 5 % are commisses of a low of the torms of the species rate of There is beart any limit to the number of these which may occur and is their relative size changes the number of these which may occur and is their relative size changes the habit as the scholar which may occur and is their relative size changes the habit of a given species is until deady due obsquifecant variations in the conditions under which it crystal zed. It has been proved experimentally that even torsize undertal presch in the crystal ring a lation can affect the limit of the crystal formed. For extinor term in rise will crystalize direct desirons from a pure water a rution by when the solution is saturated with methylene-blue the crystals will have a cubic hubit.



13. Diversity of Size. Crystals occur of all axes, from the merest microscopic point to a and or more in minieur. It is important to understand, however that in a minute crysta, the level power is as complete as up has argue one. In less, the hydrest perfection of form and transparency is fount, only in crystals of small size.

A single critical of parts in or at blain to 33 feet being and is in consumfationed on Laborated in the Total of the consumfation of the consumfat

14. Symmetry in General — The faces of a crystal are arranged according to certain time it symmetry and the symmetry in the initial again of the dynamic of crystals my contents and crosses. The symmetry that we defined in relation to all, a parise of symmetry 2) on area of symmetry, and (3) a center of symmetry.

These different kinds of symmetry may or may not be combined in the same crystal. It will be down to or that them is one class the crystals of what have toucher constructs nor plant a symmetry are all these is only a center of symmetry. On the over hand some classes have all these

elements of syn mean representated.

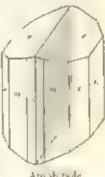
15. Planes of Symmetry - A solul is estal to be geometrically symmetrical with reference to a prane of symmetry when for each race, edge, or et id angle there is another sum ar face, edge or angle which has a like postfrom it the opposite ade of this paint. Thus it is ill yours that the crystal of

amphibole, shown in Fig 9, is symmetrical with reference to the central plane of synapstry judicated by the

shad.ng

In the ideal crystal this symmetry is right commetry in the granetrical sense where every men on he are side of the plane of syndhetry has a corresponding point at equal distances on the other aute, theasured up a line norma, to it. In ther words in the deal geometrical symmetry, one half of the crystal is the exact mororintage of the other half

A crystal may have as many as nine planes of symmetry three of one set and ax of another, as is illustrated by the cupet (Fig. 16). Here the planes of the first see. pass through the crystal paralel to the cubic faces they are shown in Fig. 10. The planes of the second set join the apposite cubic edges, they are shown in Fig. 11. A

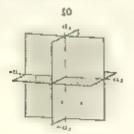


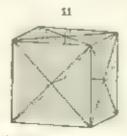
Attack hole

plane of symmetry is always a possible crystal face and its normal is always

para lel to a posable intersection between two crystal faces

16. Axes of Symmetry It a solid car be revered through a certain number of degrees about some line as an axis, with the rest i tent it og " occurres precasely the same position in space as at first, that take to said to be an axis of symmetry. There are four different kinds of axes of symmetry among crystals, they are define, according to the manner of the es which the crystal reports used in appearance during a compacte resource to of 364 An ax s of symmetry is a says norm of to a possible crystal fact and parallel to the edge of intersection of two crystal faces.





Symmetry Planes in the Cubo

(a) A revotal is said to have an exes of bonary, digonal, or twofold symmetry when a revolution of 180 prestures the result named above in other words. when t occur es the same post on twee to a complete revolution. This is true of the crystal shows in rig. 12 with respect to the vertical axis card disdeed each of the horizontal axes also,

The regulary between the turn geometries, symmetry and the actual crystall graphic pyrometry is discussed in Art. 18. I This is the care of the numbed case of the sometric system.

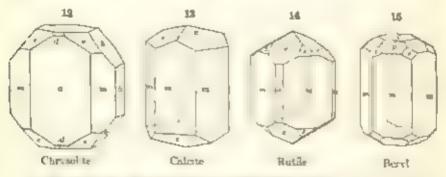
(b) A crystal has an axis of trigonal, or threshold symmetry when a revolution of 120° is needed that is when it occupies the same position three times in a complete revolution. The vertical axis of the crystal shown in Fig. 13 is an axis of trigonal symmetry.

to A crystal has an axis of tetragonal or journal symmetry when a ter matter of the preales for in other words, when it occupies the same position that takes it a complete revolution. The vertical axis in the crystal

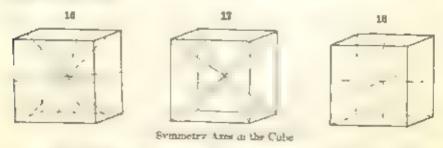
shown in Fig. 14 is such an exis-

(d. Final a cryscal has an axis of heraponal or world, symmetry when a revolution is to do? is called for, in other words when it occupies the same position six times in a complete revolution. This is flastrated by Fig. 15.

A remineter aim which are forms the most distribution of throof more expansively plants is conserved by preferring the to there as a displant of the fall forms and a few files followed and is of a numeric axes are some them as displants and dependence.



The rate \* dissipates three of the four possible in a devanuetry with respect to any of symmetry. It has no assumed to any represent provide the model, some it appears edges the 15 - 1, has but seen of represent an animal the appearance of any in the 17 - 1 has, finance, three area of securious type meter putting the making points of appearance faces. Fig. 19

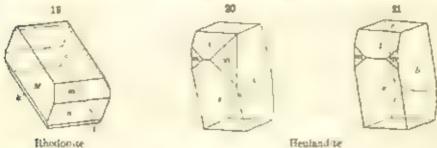


At axis of symmetry is territed an uncorrecting one when the laces at our end of the crystal test is obtained one, the faces of the appearing this a mystal arm and a sum of account reflection across by beautiful through a certain arm and a sum of account reflection across by beautiful through a territorial broaden as such as axis of afternating segmentary, their faces on the opposite

This is again the cube of the portion class of the pometric system.

enul of the erraru baving such positives that one set can be derived from the other outs by a fire during about the certifical direction of the and a reflection across the horizontal rulence

17. Center of Symmetry - Most crystals, besides planes and axes of symmetry maye also a cen er of symme ry. On the other hand, a crystal, though presented archer plane nor axa of symmetry may yet be symmercical with reference to a point, its center. This ass is true of the iriclinia



Regiond to

crists, shown in Fig. 19 in which it follows that every face edge, and edid ingle has a face, edge, and angle similar to it in the opposite half of the crystal. It ther words, a grystal has a center of sen metry if an imaginary , ne is taxes of from some point on the surface through its center, and a similar point is found on the inc at an equal distance beyond the center. Another way of expressing such symmetry is to unigne the crystal turned about an axis for 60° r 150° and a simultaneous reflection of the faces over a plane normal to the ixes of rotation.

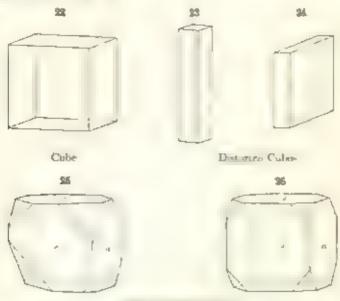
18. Relation of Geometrical to Crystallographic Symmetry Since the symmetry in the arrangement of the faces of a crysta, is an expression of the internal structure, which in general is anke in an parabel directions, the relative was of the faces and their distance from the plane or axis of symmetry are of no moment, their angular position alone is essential. The crystal corresented in Fig. 20, authough its faces abow an unequal development, but in the crystallographic sense as truly a vertical plane of symmetry parallel to the lace b) as the dealy developed crimic, shown in Fig 21. The strict greeneringal definition of symmetry would however, apply only to the second erystal \*

Also in a normal cube. Fig. 22) the three central plance parallel to each pair of cubic faces are like planes of symmetry, as stated in Art. 15. But a crystal is still ervitaliographically a cube, though deviating widely from the requirements of the strict geometrical definition, as shown in Figs. 23-24, if only it can be proved eg, by cleavage, by the physical nature of the faces, or by optical means, that the three pairs of faces are note faces, independently of their size, or, in other words that the molecular structure is the same in the three directions normal to them

Further, to the case of a normal cube, a face of an octahedron on any solid

<sup>\*</sup> It is to be noted that the prespective figures of restale openly show the geometrically plent arm a which me turn argen, and angree have the same shape, are and possition. In they works, the siral every a undoring represented as having the symmetry caused for by the strict geometries, echnican.

ingle requires, as explained beyon t similar fires or the other angles. It is not transserved between, that he simply three size of the fire, asso for a the creation agraphic sensoring 2s as as may explain the creation with reserved to the planes named as Fig. 26.



Care and the shedout

19. On the other hand, the molecular and hence the erver flographic symmetry is not always that which the granters, i.e., i.e., a.e., a grant Thus deferring for the protein he consider, ion of particles tunnetry in illustration of the fact statest is afficient by the considerable in the same and been flogrant to the term explained interior to a which he cube of the normal case of the isometric system to the symmetry described in Aris 15, 16, a cabe of the same great rich form to the logity them. In the example, to the strainfield case has a place of symmetry particle to the faces but culy hear that all the faces full cally hear that all the faces full cally hear that all the faces full that are and the first symmetry them. In the face was formy example, and there are no axes a symmetry particle and interior representation Fig. 16. Other near case a symmetry person and in these representation in Fig. 16. Other near case a symmetry person and interior

has been converted by a general contract and a face of the following contract whether with the angular to state of a face of the following the increase beautiful the six able forces or another or a four one make and the other pair after or time, a state of her are there pears of another taxon. The quest of the first pear of another taxon. The quest of the first pears of the said cases, a the modes that extraction as in four of the first pears of the said cases. It is the case of the contract of the contra

to the symmetry to which a repeat on the egy, bases, upon the distribution of the

faces, is only preliminary and approximate and before being finally accepted it quist be continued first its accurate measurements and second, by a number at 115 of the thor players, characters. In their proof of the symtheir factors in is affering in the analysis of its an ernal structure by the who a tile & town and tree 34 38

The method bases spen the ideas to respect a gib in all great two care results and a distance of the results are a great to the result of the results of a distance of the results of the the state of a state of the sta Bust ten whom there were on our full of the

20. Pseudo-symmetry The crystals of certain spaces approximate close to it anger and there we to opened with my is the my proporties of a sestion began to settle by the but to which were secured a technique they are then so I called pay, a require, An arous everapers are given timer be different events. This the native over been shown to be true to the december of the state of the state of the second to be an some

CHAPTER IN PROPERTY OF PROPERTY OF

I will be down a second company to or map or a define absorbingly by our regular grouping a taght right a same a same in the ball sign to the single crisial must create an are present point symmetry up, are Hiper to I year a complete II a way to be now, to per to all week, one in lar species whose create of the error of the hexagonal as the Age a gar outper a med create a the rion where species, plan per c may have more the orm to recomply a government to of the secthe resolvery. This word of part bearing he'ry also sever arreng the there if a single and one start a title in all the in the start of the company and in f mt I be north I as This is a stranger, to a we and crystal of schooling have no figured a g 442 in the conjugate of twite employed

then making our of and their or and whope there is no one forting of the Synthetry of one of or or or or one of a west grand as participation condition in CTVtals of the competition account by solid copper. The result is reached in the reason by an almer a development of lateries to the freetien of certain was of synamic ty. The subject to be assert and a morrored on a

SEPT POST 21 Possible Classes of Symmetry The theoretical consideration of the different kir is I seeming to pressible strong class als out up of the structural and was a second was at Arte 30-32, has led to be exceeded a that then are his views 32 types to a different with respect to a countrialism of the different symmetry is as a assembled. Of the third two hat ril of come to a green me because their summers when classes in Guartic far to larger it a per tary to get a perme. Item ies these water

<sup>\*</sup> The terrine pur which against may use it, his and no, our cases a train there we be used

thateen or fourteen others are distinctly represented, though several of these are of rare occurrence. The remaining coases, with presslay one or two exceptions are known in hig the restal are salts made in the laterature characters of each if the thirty-two classes are given under the discussion of the severa ervera he systems

22. Crystallographic Axes. In the descript of a crystal especially th prepared to the position of its faces, it is found in progress to persons of or the methods of and viters, geometry, certain ones possing brough the court of the rich creata, as a basis of reference. See further Art. 39 et acc)

These ones are couled no crustolographic area local lines, n & to h greater or less extent fixed a the symmetry of the crastals, for an axes of available of in almost all cases a posses e crystal graphs axis. Further the unit lengths are guest to these axes are fixed so; startes to the symmetry, sometimes by the position of the faces assemed as for interval are no unit forms in the sense befored later. The times at mes at our in log 18 are

the creas tographic axes to used, the curse faces are not reed

23. Systems of Crystalazation and Symmetry Classes. - The thetytwo page or crast's, classes which are to ngraded from one smaller by ord deministry are lassified in the took and part average both me of the sea systems (whereas several cases of firm g at my new are in their and metry. The figure chases is inversely to be the narry the story is in coperal the cold on a whole and since further lost in a the highest cognition as one ry possible for the given system, while the others are lower in grade of symmetry

It is an port set to in the that the classes our prised with it a given system are at once east, a transported toget or by too to but, but the presenting and a general separated from those of the other system is a beside a p

Boy was given a list of he eix aparents together with the ? which the classes, that the draw Theoreters I be no magneta here in task that are used in this book white in the following parentteeps to goth other equivalent natice that are also it extraon use. I neer to be all of this classes it is possible to give the game to converil or at art for a hitestoria which prosting with to I partie the chipperpool that I if the Court There a some a ght varia is he west iffered note rate he order a while the crystal systems and moses are considered, but in the mean coordinate almodern discussions of crystan graphy are uniform

## ISOMETRIC SYSTEM

(Regular, Cubic System)

1 Normat Class (Hexagonia end Holobedral Dilesseral Central) (Oh Or last 1 Carns lyne

2 Preminental Class Diskundedeestaded Peres of Renahrdral Diposited Temperal Central at the last 7 Perce Lyter

I me also of the tetrag mal in I becagot all systems are a known wide in the air constant. but the me and a her per second, a manganting upto a construction.

? For explanation of there is not up now Art. 33.

<sup>&</sup>quot;Except insign faith in the war since a story where the sine to of present a by the week of ofenguinal symmetry it goes not account to make it makes at the case by tametry Fam in a

3 Terrangual Class (Hexteraledral, Tetrahedral Hemihedral,

Ditessoral Polar IId, Te, H3d, & Tecrahedrite Ivpe

4 PLAGIOHEDRAL CLASS (Pentagonal Icositetrahedral Plagohedral Hemshedral, Gyrondal Tesseral Holoamal) [O, O, I43, 8] Cuprite Tyne

5 TETARTOHEDRAL CLASS (Tetrabedra, Pentagonal Dodecahedral,

Lesseral Polar , T T, 12,3, 5] Udmannate Type

#### TETRAGONAL SYSTEM

6 NORMAL CLASS. (Ditetragonal Dupyramidal Holohedral, Ditet-

ram and Educatorial) D4h 4Dr I4 and, 20, Zarcon Type

7 Hemmorenic Class (Ditetragonal Pyramidal Holohedral Hemimorphic Ditetragonal Polar ) (C4v. 4e, 14ed 12) logosuccunumde Type

a Tripynamipat Class (Tetragonal Dipyramidal Pyramidal Henu-

hedral Tetragonal Equatorial, (4h, 4C) 14 s, 6 Schoolite Type
9. Pyramidal Heministeria Class. (Tetragonal Pyramidal Heminisdral Heministry Tetragonal Posit C4, 4C 14, 6 Wulfemate Type
10 Spitenotdal Class. Tetragonal Sphenoidal Sphenoidal Heminis-

draf Dingona, has mobedral Dietrogonal Asternating.) (Vd (D2d); 4d [42d 42] Chalcopyrite Type

11 TRAPEZOHEDRAL (1.488 (Tetragonal Trapezohedra) Trapezohedesi Hemmedical. Tetragonal Holonomi, (D4 41), 14.2, 10] Nickel

Sulphate Type

12 Texastorroral Class (Terragonal Despheroutal Spheroidal Tetartohedral letragonal Asternating, SI (U.1), 4c, [In, 2] Artif 2 Call AlvOr.SiOa Lyne

#### HEXAGONAL SYSTEM

### A. HEXAGONAL DIVISION

12 NORMAL CLASS Dibersigonal Dipyramidal Holehedral, Dihexagona: Lapatorial > (Dah, 61) CB nune 4 Beryl Type

14 Restinospitic Class (D be ragona, Pyram d.l. Holohedral Hemi-

morphic Denexagonal Polar 1 (6) 6c, Chine 4 Zine 1c Type
15 Tripyraminal Class. Hexagonal Depyramilal Pyramidal Hemihe tral Hexagonal Errogonal ) it on 6C1, Co, in 2 Aparite Type

.6 Pyramicat-il-mimorphic (Lass. Alexagenal Pyramidal Pyramid I Herman Jan Hemma reas: Hexagona, Polar ) [08, 60, Cor, 6] Nephelite Type

17. TRAPEZOHEDRAL CLASS Hexagonal Trapezohedral Trapezohoded Hemmeoral II ragonal Holoscond) D6; 6D, Cont, 6, 5-Quartz

N DATE

18 TRIGONAL CLASS Ditrigonal Dipyramifal Trigonal Heinibedral

Ditrige day bagatoris (1936) but, fibr. 4, Beintonte Expe.

19 This Oval Tetarrolleural Class. Ingenul Dipyram dal. Trigona Pquatorni) [Csh, 6c, Ct. 1, Dunverorthophosphate Type.

### B. TRICONAL OR REPORTS OF DRAL DIVISION.

### (Trugonal System)

20 RHOMBORLOBAL CLASS Ditrigornal Scale in Junior Hexagonal Scalet obedra Rhous-a record Herathedral Lubrange and Alterna tage, Loid 3Di; RJc, 6] Calcite Type.

21 Ruomic replace Hestric terris Cass. (Dirigon d Personala) Trigonal B made dral Henningspace Disrigonal Poist, Asy, & Ric. 8.

Tournaline Type

22 Philippose at 117 brant. Classe. (R) rute hedral. Trigonal Rhomboles. dral Rissorbohedral Tetartohedral Hazagotal Asterna and Itas at ., R3: 2| Phennotte Type.

23 Taxeexout ment Class Trigonal Temperatural Trapezoncelent Tetartohedral Tragona Hermand) D3 aD 1632, 7 a-Quartz Type

24 The SAL CUTA TOUR HOAD TO M MC COMMIC CLASS . HIGH A PVremaid. Irgonal Pour, (3, 30, R3, 4 Sodenn Periodate Type

### ORTHORHOMBIC SYSTEM

# (Rhombic or Prismute System)

25. NORMAL CLASS (Or be plour big Dipor mid., Halaber, and 1) . digonal beparture. We Date the forms to dante Type

26 H w m mente from A tremerbandor Pyramidal. Datig tal Potar )

C2v; 2e; Ima; 22, Calantine Type

27 Spring Crass Or thouse Despheno lat Digunal Holy axad) A (12), 21), 12.2 2, 9 Possonice Lyne

### MONOCLINIC SYSTEM

# (Chappie or Monogrametric System)

28 NORMAL (LARS Promotic Holohodra, D.g. Bay Falastorial) [C2h; 2Ci; C2/o; 6] Gypsum Type

29 Remotories Cass Spherould Digono Police) [C2, 2C;

C2, 3) farture Acid Type

30 CLANDHERGA, CLASS Domatic Herricatral Planar) (Th.(s). 2c, Ce, 4) Climelandrite Type

# TRICLINIC SYSTEM

# (Anorthic System)

31 NURMAL CLASS Hombodyal Piragonial Control : Ci C; or Sal; 1Cl; PI; 1 Axinto Type

32 Asymmetric Class Hemiliedia Pedia, ) Cl. 16 Pl. 1

Calcium Thromalphato Type.

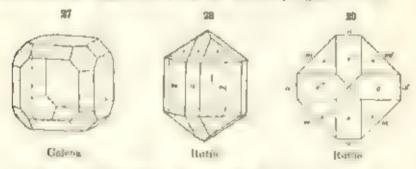
24. Systems of Crystallization; Crystal Axes and Symmetry In the throughpuths an investely friton by a statement is given describing the created lograph classes if each of the crisical system of these a syn person for every metry of the normal class of each of the different systems. The symmetry is

also given of one subordente class of the besignoral available which is of so goest importance that it is of so convergetly realed is a a besystem even when as to this work, no forms, to reterrable the same exesting the

strictly beyagona by to a usage not aloned by a anti-ps

I beautine system. There exists axes at right angles to each other ar I of equil brachs. If we like axial princes of symmetry tyrincipal planes particle to be called and by highly their intersection to crystallographic exist, say like drag on paints of symmetry, passing through each oping a particle other edges and honce particle to be faces of the rhomble distorahedron.

First or, three like axes of tetrigonal symmetry consistent with the crystal graph rowes and normal to the faces of the cabe four ake diagonal axes forger described by horizonto he faces of he netableacon, and six like diagonal axes of bit investmentry normal to the roces of the integral axes of bit investmentry normal to the roces of the integral axes of bit investmentry normal to the roces of the integral axis of the integral axis of the roces of symmetry to these relations are absorbed by Fig. 27 axis by Fig. 5, further by Figs. 110 to 143.



II Tetradoral System Theoretveld axes at right angles to each other, two of them there as a between divised lend occurs, the theoretical axis—body and get or shor er that the state two. Three axis, plates of symmetry of these two are like plates divisoriting at 90° division as the vertex of expension and he had be the diplate is transcribed as the vertex of them and hence expensions the historical axes. There are also two diagonal phases of symmetry is crossiting in the vertex lacks and assembly the two expetitions at angles of 15°.

Fatther, there is a sux softeeness to symmetry a principal axis this is the versus creatinlegrap is axis. There are used to spear main also this four ages of their symmetry like two and two lines of each pair at right makes to each there. Fig. 28 shows a typical terrigonal creation of the fig. 29 a land proper on fig. that is, a proper on contact angles principal symmetry in right to be certical axis. So also big 30 and large 98 240.

the accompany or examiners of the different casses, here and later the center of

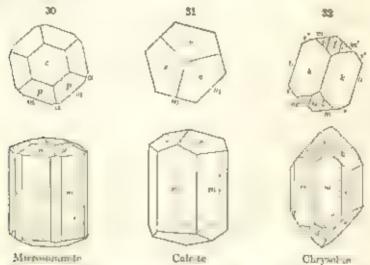
symmetry a urdannily not mentioned when its presence or alwence a olyving.

<sup>\*</sup>Two planes of eye of dry are as 1 to be like when they do not have be developed halos which are minimal to make when, others with a size one to be make from if it is a various of a size of the plane of extranetron as and the results me graphs are a consistency of a most one of planes of a most of the men and are the remove the results of a most of a most of a consistency of a size of a size of a consistency of a size of a

III HEXAGONAL System Four crystal axes, three of which are equal and is in the horizontal place making agrees of 00° and 120° with each other, while the four maxis is vertical and has a length different, organize shorter, from that of the horizontal axes. In the literaponal three or three are four axial planes of symmetry of these three are lost planes of crystallograph. These are also there plane is interpolable, is it right angles to these. There are also three other day had planes of symmetry message the three of the first set in the vertical axis and making with them applies of 30°.

Firther three is one principal axes of beingood symmetry, this is the vertical crystallographic axis, at right angles to it there are also six binary axes. The last are in two sets of three each. Fig. 30 shows a typical hexagonal crystal, with a basal projection of the same. See also Fig. 37 and

Figs. 238-245



In the Trigonal or Rhombi hedral Director of this system there are three like places of system to interesting at larges of bit in the statical was. Further, the forms belonging here have a vertical principal axes a regime symmetry, and three horizontal axes of bit ary symmetry contening with the horizontal crystal against axes. Fig. 31 down a space resamble leaf crystal with its bisal projection. See uso high 201 287

IV Outlin onth, he may Three crysta, rees at right angles to each other all of different long as Three utilize planes of symmetry meeting at 90°, and fixing by their intersections toos the passion of the right agraphic axes. Further, may make axes of hiners some very come one with the last-named axes. The 32 shows a spin south thom corrystal with its

basal projection bee also big swand bigs 316-338

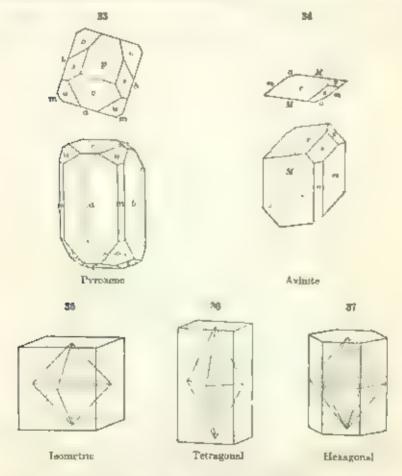
One plane of symmetry which contains the wo cryst illigraph cases in have the oblique intersection. Also one axis of binary symmetry, normal to

this plane and coinciding with the third crystallographic axis. See Fig. 33,

a sa Fig. 39 and Figs. 353-367

VI Threefor System Three unequal crystal axes with mutually oblique intersections. No plane and no axes of symmetry, but symmetry solely with respect to the central point. Figs. 34 and 40 show typical trickling crystam. See also Figs. 370, 386.

A statistical strict as how that more than one half of crystallized minerals belong bettler the orthogon who or monocless space on. The majority of uniterals crystallize in the class of highest symmetry in the respective symme.



25. The relations of the normal classes of the different systems are further illustrated both expering the crystal graphic axes and synthetry by the accompanying figures, 35.40. The exterior form is here that he must be forced that he must be shown as a challenge of the crystal axes or the forced by the central broken lines. Further, there is shown, a challenge of the crystal axes or the first beautiful to the contral broken lines.

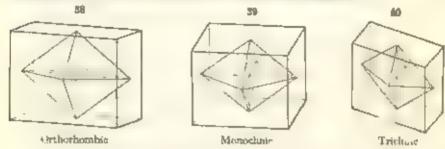
this, the combination of faces each of which joins the extremities of the unit

lengths of the axes.

The ful, understanding of the subject will not be gained until after a study of the forms of each system in detail. Nevertheless the stident will do well to make himself familiar at the ourset with the fundamental relations here mustrated.

It will be shown later that the symmetry of the different classes can be most clearly and easily exhibited by the use of the different projections explained in Art. 44, et seq.

26. Models. — Glass for transparent cell-doud models thurtraing the liferent systems, having the forms chown in Figs. 35—40, we be very usef at the stillness controlly in surround he harmonical relates a regarding symmetry. Then should show within the revetable principle ages, and he is locat threads a wire, the nu local of one is more stuppe forms. Models of wood are also table to great variety and perfection if similar hadespeakable to the student in insistering the principles of divisional replication.



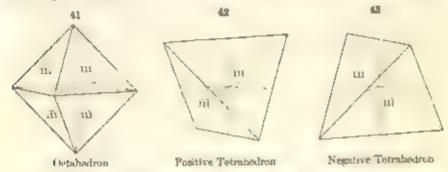
27. So-called Holohedral and Hemihedral Forms.—It will appear later that each crystal terms of the normal class in a given system embraces all the faces which have a ake geometrical position with reference to the crystal lographic axes, such a form is said to be hotohedral from oon, complete, and bod, face). On the other hand under the classes of lower symmetry, a certain form, while necessarily having all the (aces which he symmetry all was, may be have but half as many as the corresponding form of the normal class, these half faces forms are some discussion in this account han hadral. Furthermore in will be seen that, in such cases, to the given hotohedral form there correspond two another and comprendicatory hemihedral forms could respectively positive and negative (or right and lott), which together embrace all of its faces.

A stage example will beloud make the above statement intelligible. In the purpod class of the acceptant evolute, the estatesimal Fig. 41 is a commental form with all the positive faces regist in contact a sub-size after in that they must be axes at equal distances. In the terminants class of the corrections, the forms are referred to the same cross a temporal make, no the symmetric defines a Art 10 and more fasts are common for both for a car faces having the present bed. There are a four faces for both bedray from the tetrahedron both and above the positive and negative tetrahedron, when together it we be seen amount of the best of the octahedron, Fig. 6.

In certain classes of still lower symmetry a given crystal form may be a but encounter of the faces belonging to the corresponding normal form, and, after the same method, such a form is sometimes called leteroscital

<sup>\*</sup> The use of the word form is defined in Art. 42.

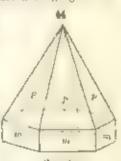
The development of the various pass he kinds of hemihedral and teturtohedral forms ander a given system has played a provident part in the crustalography of the part, but it leads to much complexity and is dead to less
staple than the direct statement of be symmetry to each case. The latter
method is systematically followed in this work, and the subject of neumearise, is demosed with the brief and incomplete is attempts of this said the
following paragraphs.



28. Hemimorphic Porms. — In several of the systems forms occur under the classes of lower symmetry than that of the normal class which are characterized by this that the taxes present are they those belonging to one

extremely of an exact symmetry and erystanographic axis. Such forms are conveniently called hemomorphic (had-form). A simple example no let the hexagonal avaient is given in Fig. 44. It is of your that believe therefore forms have no center of symmetry.

29. Enactionorphous Forms. Ly stall forms are and to be enactionorphous when passess a notice a gione nor one or of avenue by their rusy occur in two passess are aboth are more thanges of each other. The two types more a converted to an bother by any rotation but are content to each other as any the ugas and all hand and are or manners, there are passented as tight for left hand on bother are manners, over more the participated class, but 143.

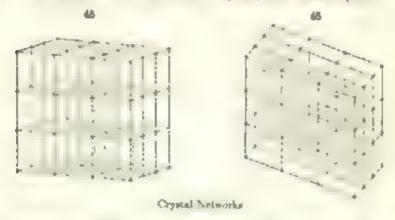


Zaneste

30. Space-lattices. Much light has recently been thrown upon the reactions existing between the different types of crystals on the one hand, and of these to the payment properties of crystals of the other by the consideration of the various possible methods of grouping of the structural upits of which the crystals are him. This subject, very early treated by Place and others menting J. D. Dano, was his used at ourth by Francentein and after by Bravais. More recently a han been extended and elaborated by Schrike, Walli Schneider, Fororex Barow, and others

When a body passes from the state of a would or a gas to that of a solid, under such conditions as to allow perfectly free acts in to the interactority forces, the result is a crystal of some definite type regarding symmetry. The suppost hypothesis which can be made assumes that the form of the crystal is determined by the way in woich the atoms group themselves in a position of equilibrium under the action of the interatomic forces.

As, however, the crystallising forces vary in magnitude and direction from one type of crystal to no ther, the resultant grouping of the crystal units must also vary, particularly regarding the district between them and the angles between the planes in which they ha. This may be represented by a series of geometrical diagrams, showing the hypothetical grouping of a series of panels. Such points may represent the positions of the elemental atoms, or the centers of similar groups of atoms. Such an arrangement of points is named a turistice, point-system or a space-lattice. A space-lattice may be defined as a notiverk of points arranged in such a manner that a struight ane drawn through any two points in equal in the late condition will hald true for any parallel and drawn through any other arrange any other arrange point.



The subject may be distrated by Figs. 45, 46 for two typical cases which are easily in deration. In Fig. 45, the most special case is represented where the peak are greated at equal distances, in planes at right angles to each other. The structure in this case obviously corresponds in accountry to the most described in Arts. 15 and 16, or in other words, to the normal class of the momentum system. Again in Fig. 46, the general lass is shown where the milecules are unequally grouped in the three large one, and far her these directions are obsique. The symmetry is note that of the normal class of the traclinic system.

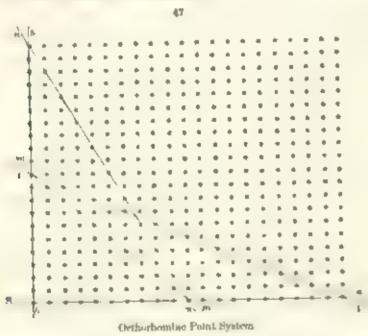
If, a cach of these cases, the figure be bounder to the simplest possible arrangement of eight points, the result is an elementary paradeterized, which obviously defines the a ructure of the whole of the grouping of these paradeterized together as coscined it is a visus that in whitever directors have been therefore it is a visus that in whitever directors have been therefore it is a visus that in whitever directors have been drawn through them, the parties will be spaced white along it, and the grouping attentions one of these panes will be the same as about at y other

31. Cortain important conclusions can be deduced from a considerate to such regular mouseular networks as have been spoken of which will be commercial here though it is impossible to attempt a fad explanation

(1) The pronuent crysts me faces must be such as helide the largest number of points that is, those in which the points are nearest together

Thus in Fig. 47 which represents a section of a network conforming in symmetry to the structure of a normal or normalise crystal, the composite

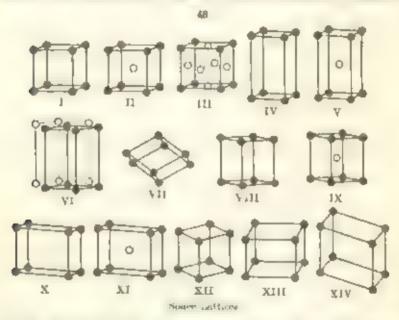
erestaline faces would be expected to be those having the position bb, as mm, then it on, and so on. This is found to be true in the saway of crystais, for the relation forms are in nearly all cases, those whose position bears some subple relation to the assumed axes, forms whose position is complex are issued present, in y as small faces on the simple predominating forms, that is in modifications of them. So called actual forms that is, forms taking the phase of the simple fundamental forms to which they appreximate very closely in angular position, are exceptional.



(2) When a variety of faces occur on the same crystal, the namerical relation existing between them, that which fries their particus noist be returned and assisted in the complex camerical returns to be expected in the components. This is explained after, is found to expected or as a fundamental law of crystals. Thus, in Fig. 47 storing with a face meeting the section in month would be section in face and for the rate of 1.2 in the directions be and a, on would be use congruence with the particle.

If a crystal allows the natural easy fractive, ented cleavage has to a mountain of cohester, the charage surface toust by a surface if relatively great as less that crow large that is one of the continuous of factour right force has been as a large proof that that place in accept the points are closest together as furthest separated from the next unsect of place. These allows the two parts of the distance separated from the next unsect of place to be or on, then two parts of the minute and city. It is not us of the above with a normal unater the special discussion of the subject of cleavage.

S2 Kinds of Space-lattices. A theoretical study of the arrangementa of points in space so that the conditions stated above under the contribution of a space lattice would be furfined showed that there were possible only featteen such networks. These agree us to have symmetry with the seven classes defined in Art. 24 as representing respectively be normal classes of the expression in Art. 24 as representing respectively be normal classes of the expression with also that of the tragenal for the removed of the second system. Of the faction, three groupings being to the iscnerio system, two to the tetragonal, are easily in the tetragonal and the run above tested, four to the or firstly and system. We to the monocletic, and one to the traction. These fourtees, different lattices are reposented in Eq. 18. I represents the simple cubic lattice. If the body-restered cubic lattice.



which remains of two cable lattices in expensivelying in such a way that the points of the second lattice he at the certain 4 the unit cells of the first lattice, 111, the face-centered cular at as a which four case between it expensivate; IV, the tetrage rator so the primitative V the body centered tetragonal or square prism lattice, VI he 201 regulatives three of whose unit cells together form the hexage rat prism, will the rational electric VIII, no orthorhorize prism lattice. IX the body centered orthorhorize prism lattice, XI the recongetor parallelepped lattice. XI the body-centered rectangular parallelepped lattice, XII, the manuel air prescript expectation for parallelepped lattice. XIII the monocline prism lattice, XIII the monocline prescript descripted attice, XIII the monocline prescript descripted.

33. Space-groups or Point-systems—It will be noted that the foruteen space-lattices described above will real ionly the normal or implication of the various systems. They cannot therefore account for the causes of lawer asymmetry. It is necessary to exceed the theory in order to include these other classes. The points of a given space-lattice represent the struc-

tiral ands of a creatal usually described as in locales in groups of prolocales or a it is this struct in that poor was the cre to water, the ne . " we the But the space of the of there is there there are by letter there is a reclass If he act I the peast and of sec in fevil in alongs of the act to be are codes I real, other pers rice, but he had east or to the or it, on of a plant if who good a nive, can be for saved that will account for all DONG A RAPLIET BY COURSEST OF BEAR SHOWED THAT IS INSTALLING WILL FOR hite a with us to a superstrate each other near his was that the assetute of tende could be lens of to man ther by some deanite or vegices at the of six velty vallent to arrangers the or pared squeeze could be served to be The Party of the Report the Control where the sent of a state of the state of the state ran by let a se from any her are of various kinds. The maty for is ofmade up it be tanked on the city and he again to be proported at the gray deferre finances in some definite directs to a section of 2 is a contained of a gas a finance of degrees shown a figure case. I by a contained of of (I at 1 2 it which there is a potential attent, adde agts accompanies to a more, and along the lattern and the axis with an one is contact you, all A re com year I have ready lever to it reader to grow the for in light of you of the high water ment classes. The cases of langue are those that who chapter portion is forms, or me by words to self manifest have right and key most selected to cook there is refer to a recent for these masses it is prespect to work a but we may have two discripting the plant and of or appropriately of histograph to promote that a committee his book on a destruction of all any after with a replaced to the party of the care, they have two its effected to g they don't shape are a top congress from each other by the velocities which my nice DESPET THE POLICE OF SUCH ME & FI THE COURT B. WHOC IS THE COT, IS T & From a contrar on by a restrict transact of a deligible sor it and three time is not of a closest an axis with a new to proper a people borring, to the BATH OF PUBLIC I REMAIN IS LIVE IT OF AS MAJES HE HAVE MINE I THE ASSESSMENT TO LAND of derivated but were we heating a real thanks and preserved and alread the states of terms | 1960 and 1964 age ted the cours of pent sees to But it are real that there were an in waterpales) and thirty present or to any of her see water or a le oil those grays, lowering hat the arrange Herbit a table and single posts of the test of the passesses it is prothe sector's ter has on the basis of the best of points seems debton a creatal and a man acceptance of a condition before a service el cusposes I in it offered the og teg at the set grandles, then of the la former from morning frome each of these posts are stop as buy up to a se interpretate of the election is time, each of the latter two git most from all the at the search and ment pass on Alithe space on over of the cour real gracety are got to make alectical of are characterized by the same controlltar, party per ..

These two to proved and thereby types of structure can all be greeped an erths the types of the expension of the expension of the atoms are sense of only inconstitutions. But for the maintigation of the atoms are a portained to use of the X-ray metric selections are for the expension of the atoms practic appropriate to the expension of the error of the e

the second, the symbol proposes by Histon and modified by Wyckell; the thand the a motor adopted of in themati and conference beel a Zurich, A great 1930 the manages featuring those symbols in the brackets show how many different spece-groups occur in the various symmetry chases. The particular space-group in quest but adjusted by using the proper expolicit to modify the group was at it ranst mee, the fairth space-group an fer the normal class of the 1th chember system would be given the symbol 11 or 2 12 4

The following books other concern themselves wholly with the theory of space-groups or contact chapters gaving detailed descriptions. To them the interested reader neast be referred.

He ton Machematical Creat diography 1982; Right has at legacy and all of a restaular formal legace. 1974.

Scherbold Corres e ne se Hera bang me a menantur der Entarmin ographischen Rh right on 1884

Schoenfler, Acusta existence and hypotalists afor, Dell Pheorie on Knistalistical

tur, 1923

Supermerteld. Physik we go begin highly life.

Tatton Crystalogram and Pros. all rists, Mosester and Vot I, Chapters 30, of

Wyckoff The Analytica I storement of the Reseits of the Theory of Space-Groups,

522 to strained a second

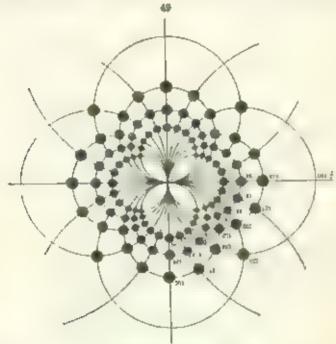
In the action is the applicant "to p (\* 100) a given a tabujer form a comfurtiment of the varieties of the are in one of space-groups

34. Analysis of Crystal Structure by Means of the X-rays. - In 1912 about that the years of ar the first form a it is of the two bundred and it is y grant greates the theory of eyes being up out and alse receives a debn e proof when , was sensored that a hour of brings mound suffer rethat my good the on by the state of the Lorented Arana discovered n 1800 to Raniger on presented by the payent muting free, in call are be a view of the bearing they be I put a me a dealers have The elementary and were highly of the Verse televal pointly metal fixed by the enthed to a de Artistation, Antoldron da perpetelorigationer agul alies at I because of here very ships waveleng is are able to printing if the second total granter our man experience The reflect while a discontinued to The sake but I ght certification as the power while expense to then and goes are conzer and become a harry a prosperty when I mys are te seed her gli than Physics had coppe to be give to be ever to be ever electromagnetic vity of the control of the control of the section we call gitter the saw and the director as a testing on all tays are on run, and 1000 are during and there and the parent his shope was digitally diles, por extraction of the trible to as and so to to be the continue to the transfer to the the transfer to see to to the engineers of the anguest of error oracles of error to the part they refer to the few years or the feet the manufactured of trans and the periode is near to a three stanction in a difference greet g. Andrei to the state of the spirit of the state of t Yor a to again over 1 plant of her and which appropriate plant and have a seed. When they we is no old that's should a fark special to a crasher he have judged the X real of a left of sea of ward to begin to we have the set will received the every or an engineer greaturated in term bath of here spate was the oath reflection of the

X-rays by a very large series of parallel places in the atomic structure. By this and subsequent similar experiments bear dinived the smallerty between the vibrations of X-rays and those of light and at the score cancel admixted a

method for the precess study. I the atomic structure of crystals,

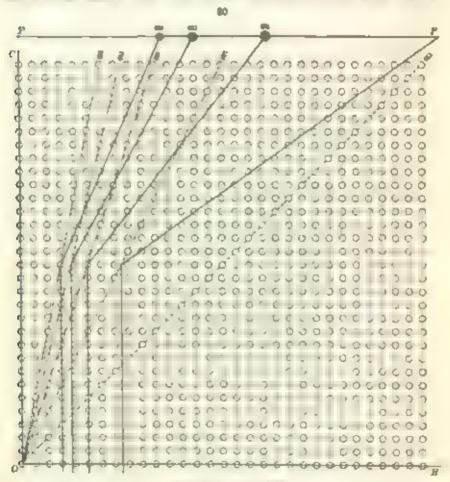
35. Lause Diffraction Patterns. In Fig. 49 is given a diagrammatic represent on of the spot pattern produced when X-rays are possed through a crystal of potassium chorade, systate, in a direct the next, if to a face of the other hard spot of the pattern in heates an atomic plane that corresponds the possible crystal face. The arrangement of the applications synthesize of the crystal, although it should be noted that the spot patterns.



Laus Diffraction Pattern for KCl

The specific a higher symmetry than that actions possessed by the crystal The specific and the relative to a variation in the rander of a come present in a given area of the retire against to be to interest to the given the relative property of the retire against the second relative the given crystal. As the connection received his time are undertailed by the market spots and are plated by the market spots and are plated by the market spots and are plated property the spots as at the attracets as of ellipses each of which present through the report of the pattern. For spots from all present again one crystal score with the pattern. For spots from all present have been recipred to circles. The second point is of the picture of any no spots. This is due to the fact that the harmonic between places had not esteep in fact one to the path of the X-rays are assistant the wave-length of the X-rays. Facts

with low inclinations are also not represented since the X-rays would be reflected at too great an angle to permit them to reach the photographic plate. Fig. 50 was said in visualizing these facts. It shows a vertical plane if rough the cubic network of potassium charide that includes the 5 (O-B) and c (O-C) crystal axes. The atomic planes having the indices (011),



X-ray Reflectant in KCl

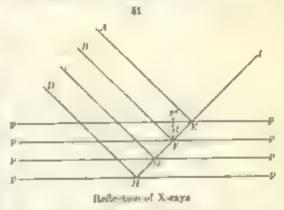
(021) (031–(041) .051) are shown by the broken lines. The line P P would represent a section of the photograph replace corresponding to position to line P P in Fig. 49. The solid lines within the fig. re represent the paties of the N says before and after reflection from individual at one planes. Reflections from 0.11 and 0.21) would not meet the photographic plate and the reflections from 0.1. 0.11 and 0.051 would show a decrease in intensity due to the decreasing numbers of atoms in the successive planes. The variance of atoms in the successive planes.

tion in intensity of the various reflections is indicated in Fig. 49, which is

much i lealized, by variation in the size of the sports

The spots of the La se patterns are the to reflection of the X-rays not from a sligle atomic pame but from a very great number of parallel planes. It is necessary therefore that the moreover it of reflected waves an full arget for to the same phase of wave in ... on an , so be able to reinforce each other or else being an different phases they would record to with each other and the wave moson in that particular J reet of sould be destroyed. The law for the reflection of \ rays is given by the equation of = 3/ s.a. 8, in waich a equals some integer, & the wave-length of the X-ray, d the distance between the parallel reflecting pianes, and 8 the angie between the path of the X-ray and the reflecting plane. This isw is magnifest to Fig. 51 waere the series of

paradel X-rays A. B. C. D. are reflected from the series of paranel planes p-p at the points E, F, G H in the hrection I. In the reflect a of X-rays according to the Laue method the distance d for any given series of sterne planes is fixed and the value of 8 is also delinite. In order, therefore c satisfy the equation and have reflection taking place from any atomic plane it is necessary to be able to vary the valet of \ In making the Laue patterns it is there-



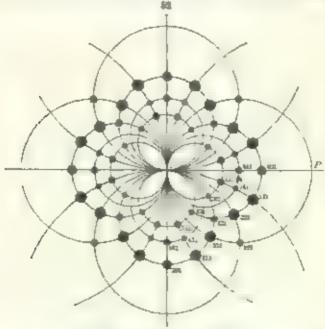
fore necessary to use the so-called ' white radiation" of X-rava which conto us a spectrum of varying wave-long his, one of which will setudy the copditions of the equation and yield a series of reflected waves, in agreeing in phase. All anti-cath sites provide some of this general rad a on in addition to heir own peculiar wave-length but in the case of platimin or theirsten the amount of such radiation is at a maximum and these are the metals

commonly used as appendicules in making land piet res

Fig. 52 gives a diagrams also representation of the Laue photograph obtained from a crysta, of balite, sod on elderade Comparison of this figure with that representing the spot photograph of potassium chloride shows marked differences in Fig. 52 there are in spots at the intersections representing the parties (501), 521: 541 34.) etc. Further, the intensities of the speed do no vary in a regular manner. The explanation of these differences les in the fact that in putassemin el loride, the petassium and eld iring atoms have nearly the same atomic weights and nearly equal powers if reflection of X-rays Consequently the atructure of polassiam chloride as far as A rays are concert sil can be considered to consist of only one said of atom, as a represented in Fig. 50. In sodium obloade, on the other hard, the atomic weights of sod um and chlorine are quite afferent and as a result toey reflect the X-rays with inflerent intensities. The structure of soch im obtained must be represented as composed of two different kinds of atoms, as shown in Fig. 53. Some of the reflecting planes would contain only atoms of one kind,

as for instance planes parallel to 0(1) 031 (051) are either all light or all cars space in Fig. 53, while other planes is not as 021, (041) would show an internaling arrangement of the two elements. The series of reflecting planes, therefore in this structure are of two different types and should show differences in their reflections such as are seen in 1 g. 52. From these observations it is come u lest that the structure of potassium chioride can be represented by the sample cutac action, while that if socious choride belongs to the face-centered cubic lattice. I and III Fig. 48.

The two Laue diagrams considered above were made normal to a principal symmetry axis of the crysta. Other pictures could be made normal

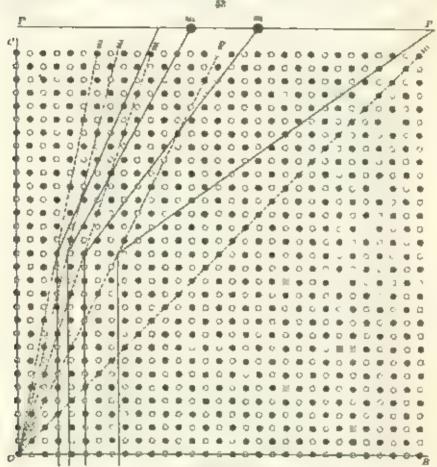


Laure Difference of Pastern for NaCl.

to other axes with corresponding differences if the patterns. Together these yet its patterns would enable one to learn in the concerning the atomic structure of the material state of To be if use the Lane pictures should have a definite and known cross a other atom.

36. The X-ray Spectrometer bear methods for using X-rays in the Larest gation of creatal structure were soon denoted. The first of these was the X-ray spectral or developed by W. H. Bragg and W. L. Bragg. W. in the neutralization in rescal is no a test to a central post which can be revolved about its axis. The armagement is cossely similar to that used in most true and treasuring creates as the or large reflection gentometer. In pace, if a beautiful ignates a term of X-rays is interiest at the creatal in the cost X-rays are reflected from a sense of parallel.

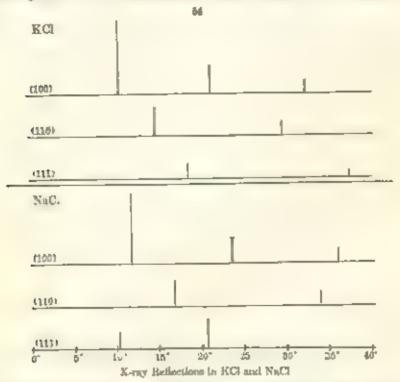
atomic planes of the crystal the angles of incidence and reflection is ng equal. The position of the reflected beam is determined by revolving an ionization chamber about the central ix, of the instrument in in the electroscope connected with it shows that the gas in the charmer has seeing connected. The angular position of the ionization chamber when this happens



X-ray Reflection in NaCl

gives the angle of reflection of the beam of X-rays. The law of reflection of X-rays has been given in Art. 35 and the conditions of reflection are illustrated in Fig. 51. In this case, however, the wave-length of the X-ray has a definite value. Therefore in order to have a series of rays reflected from the successory anomaly anness. In necessary to have a certain value of the neighbor the length of the p-th of the ray represented by BFFI, for instance, must be one whole wave-length greater than test of ray AEI, in order that when

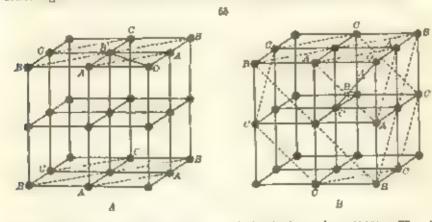
BFEI joins AEI at E, they will both be in the same phase of wave motion. The same holds true, of course for the entire series of reflected rays, each in turn differing in phase by a whole wave-length. It run any other circumstances the rays would interfere with each other and there would be no vibration along EI. With  $\lambda$  anown and  $\theta$  measured, it is possible to calculate from the equation the value of  $\theta$  the distance between the reflecting atomic layers. A similar reflection of the beam of X-rays may take place at such other angles as to make the difference in phase between the succession of



reflected rays 2, 4, 6, etc., wave-lengths, or even 3, 6, 9, etc. wave-lengths. These different reflections are known as reflections of the first, second therefore, orders. The orientation of the crystal planes from which the X-rays' are reflected must be known. By changing the position of the crystal the spacing and characters of the atomic layers parallel to any crystal plane may be studied.

In Fig. 54 is shown deagrammatically the result of the investigation of the potessium and sodium chamides by the X-ray spectrumeter. Reflections from the atomic planes pair del to the cube (100), distensivition (110), and octabedron (111), were studied in each case. In the again the vertical lines above the angles (28) at which the X-ray having the predominant wavelength of the pollady in spectrum were reflected in each case, but the lengths of these area indicate the relative intensity of the reflections. Two or three

orders of reflection are shown. From the observations with potassium chlorade it was possible to calculate the value of d for the three sets of planes and it was found that the ratio was  $\frac{1}{d_{100}}:\frac{1}{d_{100}}:\frac{1}{d_{100}}:\frac{1}{d_{100}}=1$ . This ratio satisfies the conditions found in the simple cultur lattice. Fig. 55A, represents eight unit cubes of this lattice. The chagonal planes, A, B, and C

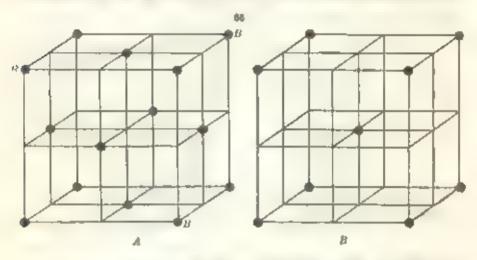


through this lattice are parallel to the dedecahedron plane (10). The distance  $d_{\text{this}}$  between the planes A and B is one-half the face diagonal B O of the unit cubic cell, therefore  $d_{\text{min}} = \frac{d_{\text{con}}\sqrt{2}}{2}$ . In Fig. 55B, the octahedral planes A, B, and C are indicated in the same cubic lattice. The planes A and B divide the body diagonal O-C of the unit rube into thirds as indicated at the points A and B. Therefore  $d_{\text{this}} = \frac{O(C)}{3}$ , or  $\frac{d_{\text{con}}\sqrt{3}}{3}$ . If we let  $d_{\text{con}} = 1$ , then  $d_{\text{con}} = \frac{\sqrt{2}}{2}$  or  $\frac{1}{\sqrt{2}}$ , and  $d_{\text{con}} = \frac{\sqrt{3}}{3}$  or  $\frac{1}{\sqrt{3}}$ . Therefore for these three interatomic distances we may derive the ratio  $\frac{1}{d_{\text{con}}} = \frac{1}{d_{\text{con}}} = \frac{1}{d_{\text$ 

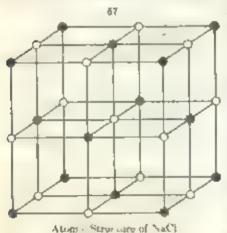
Fig. 56A shows eight and cells of the face-centered cubic lattice. Inspection of the figure will show that  $d_{10}$  and  $d_{10}$  are the same as in the cubic attree. Fig. 55A. But of the octahedral planes shown in Fig. 55B, only the plane B appears in Fig. 56A, and the spacing between such process must be twice as great as in the first case. Therefore the ratio of the three interatoms distances for the face-centered cubic lattice is  $\frac{1}{d_{(100)}}$ ,  $\frac{1}{d_{(100)}}$ ,  $\frac{1}{d_{(100)}}$ .

the ratio will become  $\frac{1}{d_{\text{time}}}:\frac{1}{d_{\text{time}}}:\frac{1}{d_{\text{time}}}=1:\frac{1}{\sqrt{2}}:\sqrt{3}$ .

The X-ray reflections obtained from some chloride, indicated in the lower had of h g 54, show certain interesting differences from those of potassure charide. In the case of the 100, and (110 places the reflections are similar but at a slightly greater angle in the case of NaC's, indicating that in



its step cture the distances does and does are a little smaller than with KCl. In the case of the reflection from planes parallel to 1115 while there is a reflection at an angle said or to the best reflection in the case of ICL, there is also another reflection in the case of NaCl at one-to the angle. This in-



theates t ast the spacing of the octahedral planes corresponds to that of the face-centered cubic lattice instend of the cubic lattice. The first reflection from the octahedral photes in N this of less rate buts there the second reflection. They a construct to the rule of regularly duncated inc intensities when the reflecting planes are all of the same character. In order to account for these facts a structure for NaCl is assumed like trut shown in Fig. 57, the solid total representing atoms of sodium, while the careles andicate atoms of eldorine or vice versa. It will be noticed that the sod, up and chlorano atoms consultered separately are placed in free-centered make attress, the two

lattices interpendenting each other to form a simple cube lattice. Note that places parametre of their 100 or 110 glow both N and Cl. torus alternal against each other therefore these two sets of police have uniform powers at reflect on. On the other hand, the octahedral places, two of which are

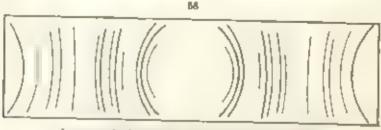
contined by the broken lines, alternately contain all Vs or all Ct atoms. In the case of Nat I the atoms we get a result in Na = 24.11 a.3 a.4, a.4 the process of the atoms, ing orthogon panels of he different to the reson it is possible to the anti-city of the resonant is possible to the adaptation confident to granes of as at another terms. In with a daptation confident to granes of the sate refer ing power. In the case of it per a new form as a dispersion of the intervention process of the resonant of the intervention process of the complete and advantaged to the sate of late and the transfer at the first and the complete and the sate of the resonant for the intervention of the reference of the remarks of the resonant for the intervention of the resonant for the intervention of the sate of the remarks of the complete atoms for the intervention of the resonant for the intervention of the sate of the resonant for the intervention of the sate of the resonant for the intervention of the sate of the resonant for the intervention of the sate of the sate of the intervention of the sate of the sate of the intervention of the sate of

The other was a the reliction between he and he is prove the streether and the form the streether than the form of the first term of the streether than the streether

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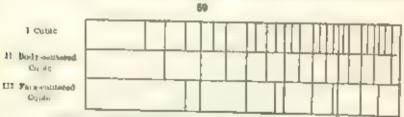
37 Other Methods of X-ray Investigation ! The Pointer of the In the mid-alson lossy described to accounts to have less to the eartly large at 1 perfect to and r to an the case or attent as a sub-contract a low more extens the errors graphs mentioned the red or by a conprints, etc. The moralist prints is rock interested in the art y live laters and Schorrer and by [61, 1 cm 1 1 to un such 1 to 1 er ilite of title of cellished to execute 1 422 1, 150 the perioder of Dear if Disease and Insome name is presented a green to the section of the cut by the section of the sectio in the path of a pears of Vriye et uniters wave gar. The pear er will certab crysta be pur as it all possible error barrolle in a ste a The edite thing will saw says be emitted to a second to the same of the same to the same group is a second of partition of the left of the partition of the same of the Dr. Com Courses a substitute that the me to a higher than he a trus is a present or about product to the per good the per of the ter-In order to give rise to a series on pettor and I is obgust the server. Le or server present the part file, had been de de by tigle of reducted and pay the wavening to a Viris and open an arrange of it can a serial parties. I have their margin to the to apply in the the street their density with the street of the street the There is not by I are excess to help as advage of the perchange in a form of exhibition laws there applied ognition as a micronormal to the medical beam of A-rays in a means of expensive was As

n the case of the Lane photographs only reflections from streply inclined planes can strike the plate. Consequently it is customary to surround the cale of pewder with a strip of film arranged in a circle upon which reflections at large angles can be at torsed. Such a fair proper is represented diagrammatically in Fig. 58. Usually only the portion of the film arong the medial



Langram of a Powder X-ray Photograph of Alumnaum

he executed line is used and upon this the reflections appear practically as strig! then The radius of the circle that the tilm makes about the powder tube lining kinewa, it is possible to be termined the angles made by the reflected rate and from these angles and the virying interesties of the reflections about no of the silections are strated, For anyther the reflections obtained from the three different cubic intrines would have the relations shown



Diagrams of Powder X-ray Spectra for Improverie Structures

in Fig. 30. The reflections show different groupings in each case and a study of the provider photograph of an assumetric substance would show to which lattice it belongs.

If Method of Rotation Photograph — In this method a crystal is counted so that a car be revelved about a vertical axis which is some known crystallograph to direction, assume a crystallograph to direction, assume a crystallograph to direction and the crystal is slowly revolved in its was. A plantage plate at placed between the crystal normal to that path of the beam of X-rays or the crystal is surrounded by a strip of plate appear from placed in a consecutive circle about a As the crystal is revolved various series of atomic planes come into the proper position for the rollection of the X-rays. The accumulation of the effects of these reflected cave produces spots upon the plant or film. Reflect its from all planes that are past led to the axis of rotation will be in the plant and their spots will be on the central horizontal fine of the plant or fine. Each series of various planes will be represented by two spots,

equally spaced to the right and left of the center of the photograph. All planes that are inclined to the mass of rotation will have their reflections lying on the surfaces of cenes whose size comes less with the axis of rotation of the crystad. Each set of reflecting planes will be represented by four spots, two above and two below the central honganial line and equally spaced to the right and left of a central vertical line. All planes having the indices the right and left of a central vertical line. All planes having the indices (Ak1) will have thour reflections lying on the same cone. This cone will intersect the plate in a flit hyperbolic and the circular film in a straight one. The points from the series of link planes will be on the first line above or below the central horizontal line. Those having in lices (Ak2) will be on the

second hae, etc. The spets to the picture will also have approximately a vertice arrange prent over each other. If a spect on the central here contal bue is a reflection from (her) the apata above it on the auccessive lines wou The (hl 1), hl h, oto From the de onces between the large of theu), (hil), etc and the distance from the rysten to the parte or file can be calcula ed one happing of the and cell of the at mar girms type. If the same erve at by or mitaled with other ax so of retainen, data can be goestrusted from which the antade of the structure can be conveil. I g on shows on grammatically the aprils of a n a met ratographet vac'l. a crystal age I he age by ag used his the areas of rolls at

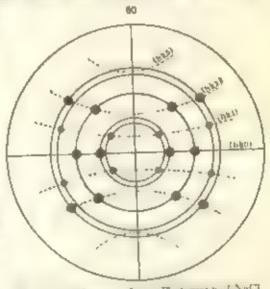


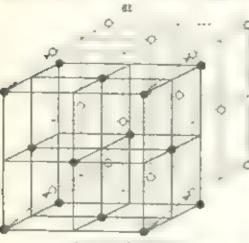
Diagram of a Restation News Phi Ogens, at And's (Axis of Restation parallel to Crystal Axis)

III The Ownthat, a Method — Thes is a prodification of the rotation method. Instead of turning the crystal is a axis though an angle of 360° it is turned back and first through an angle of about 30° from a known position. A beam of X-roys with quaterm wave-length is used and the spectra are recorded on a plotogra has pair which is shaeed behind the crystal, are recorded on a plotogra has pair which is shaeed behind the crystal, are recorded on a plotogra has pair with the used of the conduct photograph with be the theorem of the two cases.

38. Examples of Crystal Structure as Determined by the Use of X-ray Methods. - Certain interesting examples of crystal accordance that have been worked out by the use of X rays are given below as a further directing tion of the green apportunity of these methods. Lack of space will permat

only the results of the investigations to be grown and by X cave by Lame 1. Sphales de ... Then was the numeral test examined by X cave by Lame Its structure is represented at Fig. 51. The send care is night and ate the zinc atoms. They are arranged on a face-centered cause lattice. The hodow

circles, representing sulpture atomic, he can a similar lattice interpenetrating the first and which can be derived from a two movement along he body diagonal of the cube for a distance equal to one-ic inthick its length. The



Structure of System with

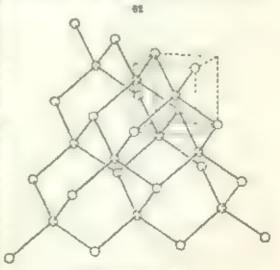
destroy or larrown of movement in order to derive one last or from the other is in facalled by the arrows

2 In swould The des months me are was also one of the earlier this sending! e their atoms are stranged on two morpeters and fare-comterest come afters the experty for early 4 it as ar zine and what it it and applicante [[ . I g 6 of the draw prints wire represented to solul at the wrongly large at that each his of he grantord structure high 2 represents the dramoud start on a different way I at culty show to in breaken to sa gers the created orientation of He structure. If it is imagined

that his figure is a sefected, extended it will be seen that the structure is see it has each carled a rose at the court of a group of four other at ma,

which taken together for the profits of a terral across are arranged in horase in rings. It is as a very solar no be support atomic group try and present by acceptance of the sirk are physical properties.

3 Complete It is interesting to compare to structure of graph is with fort of dannered Imagraphitise the cartists a retice are arranged in parallel historiing interlocking hexagona. Ing 63 represents the proportion of the soft layer of not all the to the some plane but are a ther single by



Struct are of Diamond

these hexagons is even stranger than the interstonant distances in the dia

mond structure. On the other hand the distance between successive invers or un studie horre, about two and one-had tropes the spar az a the layer tise; the water spacing of the lavers indicalitedly accounts for the foliated

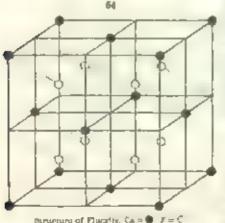
attricture and based clearage of graphing what the case-king strucare of the aid vidual layer accounts for the fact but graphite cannot be readily powdered but separates rather into min ito flakes. Thin 15 the property which makes it such a good lubricant. It is interes on ulso to note that in both diamond an agraphite the carbon in proper or are arranged in because and raws a similal atomic grouping long rocogtured an characteristic of carbon in organia compounds. Another interes ing fic. a that if the customers between the warras becausenal cings of the graph at structure be about enest a structure yers soniar to that of the dimonif can be drayed

I have by the proposition the street great fluority, wwhich the

Structure of Craple to parallel to State

calcum arong he is he points of a face-centered of a cities, while the Il cribe it tip he at he car ers of the cight stock cribes that compose one face-cut a red cut w

5 Pyride— The structure of pyrite is similar to that of fluorite, the graph atoms lying on a face-corrected calle out or, but the sulphur atoms tosses t



of lying at me centry of the eagle. so all cables, by pay bony fragon a of ends of the small dibes at a point one-fifth of the length of the largeno from ore fills ends Frig (Vi attempts to sh w this armbgereat The top you shows the describition of the atoms and electry believes why pyrite belongs to a crystal class of lower symmetry than fluorie.

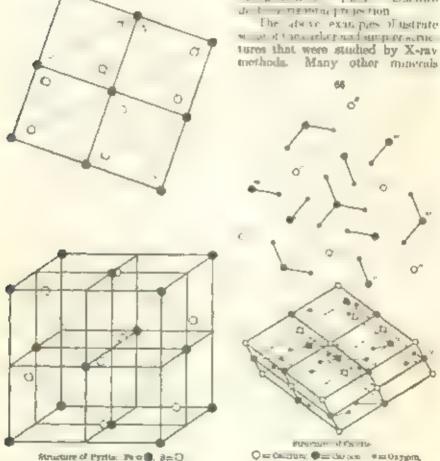
6. Calcule. - Fig. 66 attempts to show the trade arrangement of cal-The contrain and earther atong he on teterpene is, ig rhotalsphedral lattices on littler ties to be are analogo to be those of the secour and chiorine atoms in the structure of halde (compare Fig. 57). Except for the fact that the ant celefor enacte is a

rhor bohedron nestead of a cube, the two structures are dentical. It has been passe, he was concern to place the exagen a consent the structure. They are arraped in sets of three about the carbon atoms and they all he in the planes that contribution earlies atoms. ic the vertical crys as serial coxes internate with planes continuing olds the grove of motion and oxygen. The

Passing through the structure paragel places out ming in calcium atoma

are agement toth atoms in the the comment plane of the fixture manded the property do to a marring to be clon

se or a their relief and supplemente tures that were studied by X-ray



have been examined some of them as in he case of various afteriors, of considerable composity. It is impracticable to adequately treat such cuses here, and the interested elastent r ust be reterred to the original papers. The and jeet as more larly developed in the fore wing books.

W H Bragg and W L Bragg X on a and the eta Structure 1924.

W H Bragg G L Clarke

R. W. G. Wychod. The Streeture of Citystage, 1931.

## GENERAL MATHEMATICAL RELATIONS OF CRYSTALS

39. Axial Ratio. Axial Plane. - The crystallographic axes have been defined (Art. 22) as certain ages, the position of which is tarted wideters used by the symmetry of the greated and which are used in the coverious is of the faces of crystals, and in the desermination of their position and angular incommon. With hose of cets in view certain lengths of these axes are asstanced as mats to which the occurring faces are referred

The axes are in general, lettered a b, c, to correspond to the scheme in Fig. 67. If two of the axes are equal, they are designated a a, c, if the three are equal, a a, a In one system, the hougenal there are

four axes, lettered a, a, a, c,

Lurther in the systems other than the mometree meof the horizontal axes is taken as the wall to which the other some are referred, hence the court is of the exest express streets the army ratio. Thus for supplier forther rhombic, see the 67, the axial ratio is

$$a:b:c=0.8131:1-1.9084$$
.

For rutile (tetragonal) it is

$$a = 1.004415$$
, or samply,  $c = 0.64415$ .

The plane of any two of the axes is called an arral plane, and the apage included by the three axial protects an origin with the total space about the center with a days led by the three axes into eight parts. It the hexagonal system he wever where there are three to azontal axes, the space about

Detharhombte Cityital Cim-

the conter is neverted into twelve parts or sectionts.

40. Parameters, Indices, Symbol. - Parameters. The parameters of a place consist of a series of numbers which express the relative interest to of that plane upon the crystallographic axes. They are given in terms of the established and lengths of those axes. For example in Fig. 68 let the rines (1), (1) O/ he taken as the direct use of the crystall agraphic axis, and let OA OB OS represent their unit lengths, lenguated always in the surve orders by the atters a, b, c. Then the intercepts for the plane (i) H.k.L. are OH OA, OL, for the plane 2) 4 VM they are OA OV OM terms of the unit counts of the sacs there give the following parameters.

(1) da : 46 : 4c

(2) la: 46 : 2c. nnd

It is to be noted that since the two places HKL and MNA are parallel to each other and hence crystallographically the same, these two sets of parameters are considered to be , lentical. Of visually each of them may be charged into the other by multiplying or dividing by 4

In ces and Symbol Simplified and abbreviated expressions which have been derived from the parameters of a crystal form an commonly used to give ite relations to the crystaliographic axes. These are known as indices,

A number of different methods of deriving indices have been devised and several are in use at present. The so-called Muler underes are raise wilely er proyer, and with he exclusively used in their work. Below, a obser pti in of the other in portain, as a case of indices is given together with the necesears directions for transferring one type into another

the Miller natices that be derived from the purameters of any form by taking their reciprocass and evering of frue one if necessary thur sustainer

take the two sets of parioneters as given above

By inversion of these expressions we obtain

In the case of (2) it is necessary to clear of fractions, giving

The indices of this form then are to 3h 2c. The letters in teating the different axes are commonly dropped and the indices in this case would be

66

who to form

written sumply no 132 the intercepts on the different axes being indicated by the order in which the numbers

net given

A general expression frequently used for the and cos of a form belonging to any crystal system which has three crysta graphs axes is Akt. In the hexagonal eyetem which has for ricked this becomes hed. If the paramcters of a form be written so that they are fractions with the numerators always unity then the denoustrators will become the same as the corresponding and ess. The general expression in the oase. would berefore be, parame-

$$tern = \frac{111}{h \, \kappa \, l}$$

The symbol of a given form is the milies of the fact of that form which has the simplest relations to the cryst illographic axes. The symbol is commonly most to be ignate the

Var as examples are given below illustrating the relations between parameters and indices

<sup>\*</sup> In the hex gones system for more one in hose anapted by Bravasa after the method of Maler

	Pa	(TATES	-				Miller's	Symbol
10	16 :	30	-	łα	ф.	je.	-	221
da la	35	, 1.,	-	Įα	Įδ.	ţc.	*	212
la La	86	20	-	fa.	Įά	\$C	4	201
fiel La	25	×	pik	la ·	48	ja	4	210
Atl	85	80	pm.	[4	16	de.		100

If the axid intercepts are mean red in settled on the saxis or to the left on technics or below on the main they receive a five and a majors sagn to placed over the corresponding man are of the matter, as

Par	Indican			
4	14,	Þ	-	221
5	1,6	t		201

Different Systems of Indiges. The shows and this fire the mane as the parabolic desire of when it was a size are expenses as the of size it when it is a greater to a larger the relative transfer to the order to when it is a greater transfer to the order to when it was a parabolic form to the transfer to the order to when it is a parabolic form to the transfer to the order to when it is a parabolic form to the order to the order to the order to the order to when it is a first to the order to the

## EXAMPLES OF INTOCES ACCURDING TO VARIOUS SYSTEMS OF NOTATION

N	N 2 L 1179	[ 5:k	u-27-41	Mater
1a 1b a 1 1 2b 1 2c 1 1 2b 2c 1 1 2b 2c 1 2c 1	0   2 2   20 00   P2 00   P3 00   P30	1-2 2-1 1-2 1-4	20 20 20	201 100

was tage to the entered of the centering success to be mercual agreed from the electron of the role of the proof of the role of the proof of the proof of the role of the proof of the role of the rol

on sted. The fieldschmidt in time are easily converted into the Miller indices by adding I as the then tights an areas of a continue and store stone and store and store the foreign and the Maner Bravens instance for the foreign and

system are given a Art 173.

41. Law of Rational Indices. The study of crys als has established the general law that the ratios between the intercepts on the axes for the different faces on a crystal can ask its be expressed by su antal numbers. These ratus may be 1 2, 2 4, 2 3 1 0, ere, but never 1  $\sqrt{2}$  etc. Hence the vacues of had in the Miller symbols in six always be either whole DISPHAYS IN CARD

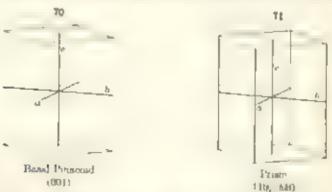
If the form whose intercepts on the axes a b c determine heir assumed that engine the graft form as the called as web chosen toos nathernal values of the whees are in it is eases very stague. In the Maler symbols,

O in I the publisher from I to beare most countries

The above law, which has been established as the result of experience, a fact follows from the experience an of the mercufar structure as funted at it, an earner paragraph. Art 31)

42. Form. A form in cryst-diography includes all the faced which have a like position reneitye to the planter, of exes, of symthe full moan age of the word be appreciated after a study of the severy avarence. It will be seen that in the most general ease, said of a form having the synerod dust, whose planes meet the assumed and ux mot anequal lengths, there must be firtye got also frees in the nonpetral system, (see hig 130), twentyfair if the hexogenal Fig. 244), action in the terragonal Fig. 205 eight in the cethorh rather bug 600, four in the monochain.

and twe in the true ner . In the hest long systems the faces named vication ene seed as all as beneen the forms a called a costel form. In the remaining two systems this is not true, and such forms in these and other cases are



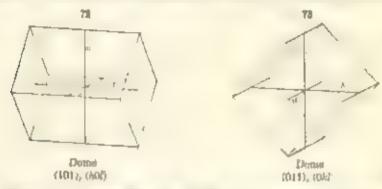
called open forms. Fig. 316 shows a crystal bounded by three pairs of unake faces each pair is hence at open form. I uss 70.7's show open forms

The and of fundamental form is one where the parameters correspond to the assumed and magths of the ares Fig 69 shows the unit pyranud of

<sup>&</sup>quot; The merron could in referred to in much rate

sulphur whose symbol is 111) it has oght anniar laces, the position of which determines the ratio of the axes given in Art. 39

The forms in the momental authors are special than find nature, given inter. In the other's area after a remaining or and many or are as a special to be brook with a may be intelly monthing after a some A carm whose faces are parametric two of the axes, as consed a parametric from



that exhibit a form of the period of the per

Is but I 50010 as a pinza and so the a 120 are prior as; \$(1011 and \$(021) are drings, as the open forms. I make a 1s to a prior to the gradient forms. The pulse for the second of these cases as were treated as if the position.

74

As shown in the manner ones the symbol of a fermior or or a cocinder in passecthoses, as 1.1, 100), or it may be an inackets [ 1] or 1 ;

43. Zone. A zone melados a series of faces on a crystal whose interest the class are run only paralle to each other as the action has drawn brought be crater of the crystal called the zone-ar x. It follows had all edges between the faces that are in the same zone are mathally parallel to each other and to the conservations are mathally parallel to each other and to the conservations. Some sample manners at teation exists in every case at tween a . Is faces in a rope, which is expressed by the zonal equation are Art. 50). The faces m. s. 5. Fig. 73) are in a zone, also 5 and 4.

If a face of a crystal a bescaltaneously in two sense it follows that its symbol is fixed and can be intermined from the two motal equations without the measurement of angles. Further it can be proved that the face corresponding to the intersection of two zones is always a possible crystal face that is not leaving talence yours or the indices which define its position.

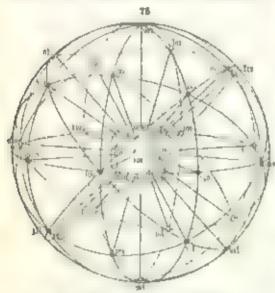


<sup>\*</sup> In the tetragonal system the form 100 is however called a promising 101) a

In many cases the round relation is nevious at eight but it can always be determined, as shown in Arts. 50, 51 by an easy calculation.

Businestines will be given after the motheds of representing a crysta, by the various projections have been explained.

44. Horizontal Projections. In add ton to the usual perspective figures of erverals projected and be based place of the regard role that are normed to the prisonal cope are very convenient a used. These give a fact a map of the crystal as viewed from the very surple examples. In these the surcessive faces may be in these of years as the facts may be in the saccessive faces may be saccessed as a saccessive faces are saccessive faces and the saccessive faces are saccessive faces are saccessive faces and the saccessive faces are saccessive faces are saccessive faces.



Spherica Projection tafter Pential !

direction of the axes a, b, B, that is, counter-clockwise On the constructs p of these projections see Appen ax A.

46. Spherical Projection. — The study of actual crystals, particularly regarding the angular and zonal relations of their faces, is much facilitated by the use of various projections. The simplicit of these and the one from which the others may be derived in known as the reterior of projection.

to making a spherical projection of a crystal it is assumed that he crystal ites within a sphere, the center of which control each crystal (as the point of intersection of its crystallographic axes) from assuming crystal are drawn to the

process we haves of the crystal and continued in in they maps the surface of the sphere. It products to which these morands to tell that surface locate the poles of the respective faces and together form the spherical projection are shown in Fig. 75.

It is to be potent hat all the poles of faces which he to the same a men if the case id. It is easily part he foll open the same great error on the sphere. This is the strated in the figure in the case of the sames and a point of the sphere in the case. It is the whose pairs follow the same great error of the sphere in projects it must be in the same great error of the sphere in projects it must be in the same great error of the sphere in projects it must be in the same great errors has in two or more male pendent for is, as for instance of the interpretable for the angular resist ons between the faces on the crystal are of course preserved in the angular cost of the sphere and between their respective poles in the spherical projection. The largest between the poles, however, are the supportmentary angles to.

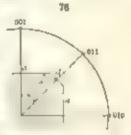
those between the faces on the crystal as shown in Fig 76. The supplement ry angles are those which are commonly measured and recorded when starting a cristal see Art. 235).

The apherical projection is very useful in getting a normal picture of the relations caseing between the various faces and zones, upon a crystal bat be-

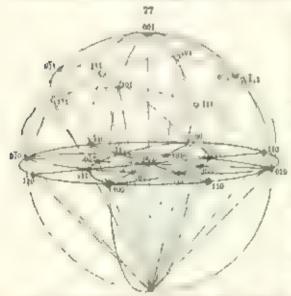
case of its nutsite does not permit of the loss study and accurate measurements out in ay be moste on the other projections described below which are made on

pane surfaces

46. The Stereographic Projection. The sterior graphic projection to we have considered as derived from the appeared project to it the forward matter. The author of the project to be commonly taken as how at rail plane of the sphere. Imaginary lines are drawn from the poles of the sphere all property to the south pole of the sphere.



the school has precedured to be equal or as we the poles of the stereographic properties. The related between the two projections of shown in Fig. 77 La. 78 shows the same steriographic proper in with a Cohe Cres. preming of log 77. Common verify the poles that he is the correspondence in the stereographic proper on mehalogith a conducting or are transferred to the stereographic proper on



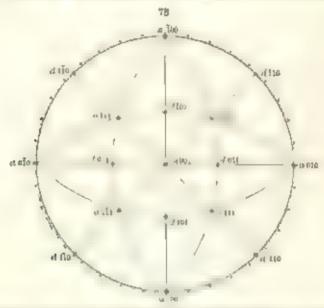
Relation between Sphericas and Stereograph a Projections

per a like a removable ing the sternographic pronection need to be noted. Its most important character is that all circles or cirgular area on the apherical projection are projected as area firms cardes on the al group spine projection. the poles of all erve hat fames that nee pages it to the vertical erratallegraphic mis fall on the formulas of the splented projection and occupy the as ne posit opain the stereographic projection. The pole of a horizontal face will had at the center of the stereographic projection All north and south an endume of the aphenoul. projection will appear as straight radial hines in the atereographie projection

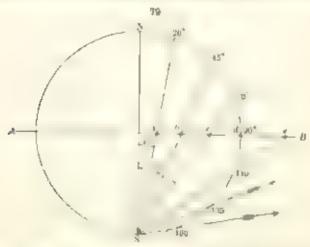
(i.e. as area of circles having infinite radii). Other great on lesson the spherical projection, as already stated with he transferred to the stereographic as circular area. Examples of an these are shown in Fig. 78.

<sup>\*</sup> For proof of this statement see Penfield, Am Jour Sci., 11, 10, 901

The angular relations between the poles of the various faces are preserved in the storographic projection but the shear has since corresponding to a degree of are unitary a sucreases train the context of the projection operation



Six cographic Propertion of the benjotes forms to a statistion, and Dogs abstra-



encounterence. The is distincted a Fig. 79 where the error represents a ,error, section through the spherical projection at 11 c line 4. B represents the trace of the horizontal plane of the sterrographic projection. A point

20° from N on the sphere is projected to the point a on the stereographic projection, a point 45° from N is projected to b etc. In this way a protractor can be made by means of which angular histories from the center of the stereographic projection can be read by determined. Fig. 50 represents such a protractor which was devised by Penneld.\* The mathematical relation between the knear distance from the center of the projection and its angular value is seen by study of Fig. 79. If the radius of the crose of the projection is taken as unity the distance from the center to any less red point as equal to the tangent of one oad of the angle represented. For instance the distance from the center to the point a sequivalent to the tangent of 10°, to point a life tangent of 35°, etc.

Fig. 81 represents a chart used by Penfield for making storcographic projects as. The circle has a danceter of 14 cm, and is graduated to asgrees. With it go certain scales that are very isoful in century the casarist

pents and a nal overes - these will be briefly described later

For detailed descript one of the principles of the stereographic projection and the math six of its use the resource is referred to the various brooks and autories, the titles of which we given beyond. It is possible here to give only a brief outline of the array important methods of construction used.



Sterrographic Productor for pleing Sterrographic Projections after be dield,

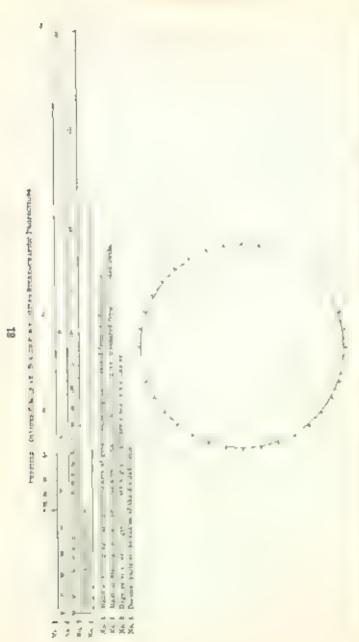
(1) To locate the pile of a face lying on a known north and south great circle, its angular lixtonce from the center or a point on the circ inference of the point year on bring given. The strengeriphic proteictor, I g 30 or the tangers relation as a cost above, gives the proper distance. The point labeled a coordinate

metric octalisation). Fig. 78, may be located in this way

(2) To become the projection of the one of a great circle which is not a mostle and as the merch is or the opinion. The projections of three projection of the circle will be still a circular are, its position can be differentiated by the usual geometric constraints to for a circle with large points on its are given. If no a condition y the case, the pages where the great circle crosses the expansion in the ungle of makes with the equator are known it is possible to get the ending of the projector, are directly from reads No. 1 Fig. 8). The location of each a general are possible to get the ending of the projector, are directly from reads No. 1 Fig. 8). The location of each a general

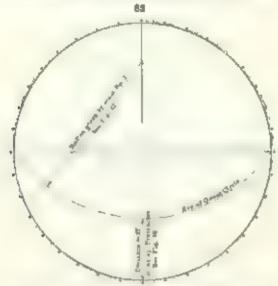
17846

<sup>\*</sup> This pretractor are the other restriction and a size and by Personal can be obtained to the Maiors speed Laurantiers of the Studiedd Sciencific School of Yale Unversity, New Haven, Connecticut.



On the couples and about the contract accounts of them as to decrease. The problem are the former for depression to problem the depression of the problem of the problem.

(3) To locate the position of the pole of a face lying on a known great circle which is not a north and south mer dian. Is angle from a point on the circumference of the projection being known. The projected are of a small vertical circle, whose radius is the known stagle is arown about the point on the circumstage red angular distance from the given point, the intersection of this circle with the known great circle with given point, the intersection of this circle with the known great circle with given to desired point. The radius of the projected are of the sign, vertice circle can be decermined by finding the position of three points. In the projection which have the required angular distance from the point given on the circumference of the projection and then obtaining the center of the required circle in the usual way. Or by the

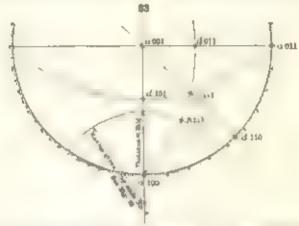


Location of the are of a great cardo or the Stereographic Propertion at a given negleutors of the equal or

to be receded in the known perit on the created at obtained directly. It is to be receded in the known perit on the created refer of the projection, while the strength is creater of the small error as not the actual center of the small error as not the actual center of the projection. The center will be a side to certain ference on a center of the projection. Therefore, even it the recents of the required are as taken from Scale No. 2 it will a necessary to each oil at least one period of the required are in the required error in or or to find a center—these pathons of construction are directly to be given by the pole in the pole in the respective to the period of the pole in the poles a project refer a which act on the great circle passing brough the poles a projectic rather and a assumetric oct bestron), and makes a known single (351°) with a.

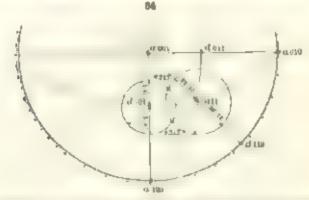
(4) To best the position of the pole of space green the angues between it and two other faces whose poles we within the it said that the faces whose poles we with the project of the two known points small circues with the proper radii and

the desired point will be located at their intersection. The two small circles may touch at only a single poin or they may intersect a two points. In the latter case both peaces will meet the required conditions. The positions of the projected small circles are reachly found by drawing radio from the



Location of pole of trapezohedroc, a 2x1, in Starrographic Projection

center of the projection through the two known poles and that laying off on bose rade points on a torthogolf the known poles with the recoined algorithm distances. The center is from found between these two points a cach case and a circle drawn through them. The unceff this circle widthen be everywhere the required mamber of degrees away from the known pole. The re-

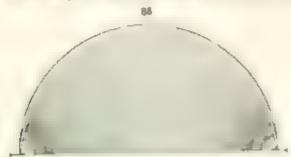


Location of two poles of hexnetahedron, i, in Stereography: Projection

quired points may be found readly by means of the Stereographic Progractor Fig. 80, remembering that the zero point on the programmer must aways be at the center of the projection. This construction is illustrated in Fig. 84, in which the points a (countric hexoctahedron), are 22' 12' and 19' 5' from

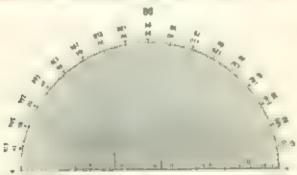
the points a sometric octahedron), and d (sometric dedecahedron). It is to be total low use, that while the sounts and d are the street graphic centers of the excles about them, he actual centers are points which are somewhat further out from the center of the reject of

5) To measure the ingle between two goes points on the idereographic projection. If the two points up as the excutaterence of the projection the



Stereograph a Protocolor groung the great or less of every attenuate degree second, fourth

angle between them is read directly from the dismons of the circle. If they he ore the same rise to have in the projection, the single is given by the use of the Standard plan. Provide it, high St. In a her cases it is necessary first to find the are of a great circle apara which the two points in . Thus is most casely more rights as by the use of a transferent calcular protector, a upon with the ares of great includes are given, high St. Phose this protector is ever the projection with its content and with the content of the projection and



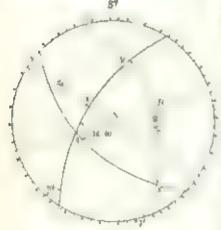
Sterrographic Protestor giving small circles for every degree monaured from a given past to the are undergoes. After Pentidd collected inches?

turn it about until he required great circle is found. Note the points where this circle intersects the circumference of the projection. Then place a second transparent postractor on which small vertical circles are given, Fig. 86, over the projection with its cites on the plants of the circumference just determined. Now note the angular distance between the two gives points. The whole operation may also be done by use of a third transparent protractor, on which the arcs of both great and small circles are given.

(6) To measure the angle between the area of two great circles on the stereographic projection. This is that conveniently accompassed by constructing the are of a great circle which shall have a 30° ratios about the period of which the two area in question cross each other and then reasoning the augman distance between the two possits at which they intersect this great circle. Fig. 87, after Period I, we serve to down as either the had. First, if the great circle that areas and to between the divided circle and the area of

the great circle that grosses if at ( ), as only necessary to draw a sir ght necthrough the center of the propertion, N, which shall intersect the disk of circle it points all assemble from ( ). This line will be the proper or of the

are of a great errole at at the sphere at 90° det of from C. The angle at C be take do errorroot by measuring with the stereographic protractor is angle between a and p.



In the case of the tople street, two great circles that their it some point within the dander, circle us at the projected or of the great circle 00° dis out from the point of the great circle 00° dis out from the point of the great circle 00° dis out from the point of the great circle 00° dis out from the great circle 00° dis out from the great of the through a to the point B. The required are will pass through this point and the points place p' which has one to the points place p' which has one to the points of which the like the like the projected of the points of the points of the like t

right setween z and y remarked on the great cards gives t so an of the reservoir at x. This is most read by right and y the use of the trace part t restricters allowing small carbon, fig. 36. This is proved to project to find p to p and the eight between x and y read directly from t

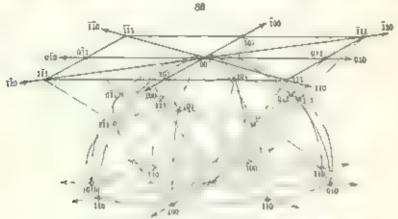
We might a fractibed a sterrographic rat, what gives he right and small crows for every two agrees. Over the is placed a stood of trong paint open which he sterrograph to project the region of the paper is for read at the center of the distingtion of the fact of the paper is for the interest to the strengt in our tropy when a magnetic at distingtion of the region of the strengt in our tropy when a magnetic at distingtion of the strength of the paper is the strength of the paper in the strength of the paper in the strength of the paper in the strength of the strength o

I's inples of the asc of the stereographic projection will be given have

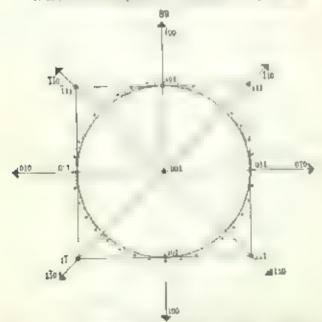
under each crystal system

47. The Gnomonic Projection, The considering it is, he derived from the spherical projection and he indeed must be considering it is, he derived from the spherical projection are Ar 45. In the case of the greater project in the pilite of the project of as stilly then as the horizontal part which has tangent to the north pole of the spheric of the spherical projection. The ngivery area in the content of the spherical project of the content of the spherical project of the project of

constitute the ghomome projection of the forms represented. Fig. 88 shows the relations he were the spherical and gnomome projections, using the same isometric crystal forms (calle, schabedran and dielectron) as were em-



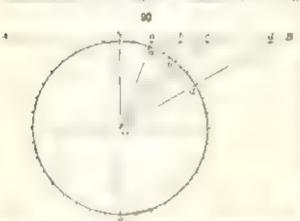
Relation between Squeeziest and Common. Projections



Cuara are Projection of Cube, Octobedroe and Dode abedron

played to illustrate the principles of the Stereographic Projection (Art. 46 log 89 and we the ground out project of the access to force. The following features of the grounding projection are important. All

great circles on the spherical projection become straight lines when transferred to the gromonic. It is poles if a series of cross of faces which by orgin the same zerie will therefore on the greater the projection he on a straight and. This primary destinction be with the adverographic and gromotor projections will be received as in the top face of the current face at the control face of the current face in the pole of a projection. The poles of vertical crystal faces will be on the plane of projection and a rather the distances rome the control That is shown by a consideration of Fig. 55. So faces are admitted by the distance in the projection of the projection of the second faces are accounted by the distance of the dista



the borizontal plane must (requestly be india cated in the same way.

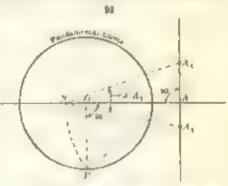
A simple relation exacts in word the mean distance from the conter of the preportion to a given pe at at 1 the angular distance represented. This is shown in Fig. 90 where the circle is assumed to be a vertical gross section of the spherical projection and the state of the plants of the guomonic projection the guomonic projection the guomonic projection that the guomonic projection that the guomonic projection that the guomonic projection the guomonic projection that the guomonic projection that the guomonic projection the guomonic projection that the guomonic projection the guomonic projection that the guomonic projection that the guomonic projection the guomonic projection the guomonic projection that the guomonic projection that the guomonic projection the guomonic projection that the guomonic projection t

tion. It is evident from this figure that if the polities of the course for as then the linear concrete A a A b' etc. are the target a filte argles 21", 3" ptc. Consequently in the grounds; pro, the send store a given proc from the penter of the proper on, considering led into it doesnot O.A. Ex. 90 in both, ye wight to the target of an argh risposan ad-In the case of the storongraphs projects t this defects a regard to be but go that one half the noise one Art 46). The stere grains since tosslar the storeographic prestranger, bug 80 can therefore be ado, sed for use in the gion and project on by taking he peaks to it reading at tweet the desired angle. The sumpost must said of platting be writer as to make a direct use of the triggent read on. The custom 11 V Lg 90 is token at some convergand eagth and then by mu to any based then by tot me and tangered of the might nevered the linear of the price in ignession from the enter of the property is It , set for any of the helpsen O A setuaco where In thak ng a go to at proc. In a circle a contribute brown about the centor of the projection, knows us the fundamental circle with a rules so also this chosen districe. Transaction that have an angular instance of 45° will the center point of he propertion will be on the exception over if this execut Community also the gar arrac present on as surrounded by a square per der of two parts of lives on which are inherted the direct as in wirel he the poles that commot appear on the projection because of the vertical or steeply inclined position of their faces. These characters are shown in

Fig. 89

To measure the angle between two poles on the grammac projection — In Fig. 94 of 4, and 4, or any two process the angle between which is desired borst draw a strought line through them or, in other words, find the threetion

of the zonal the upon which they lie. Next erect the line O. A perper leular to his senal line and passing through the center O of the projeti n. Oh, as line establish the point N, the distance A. A being equal to the hypethemise if the right triangle AOP or the distable A P Despoint Norkhown as the regle-point of the zone A, te The angle A A 4 is equal to the desired angle between the position A at | 4, In the case of zonal lites that pass through the error of the projections this angle-point wil be an the errour ference of the for lancoutal erece at the territors

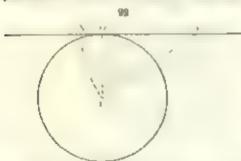


Mean rement of engle between any two poles.

( C. 4<sub>0</sub>) on the Common of represent

of a rudi is which is it right angles to the sonal are it presents. In the case of our rule ryer I faces whose property at an addite discase, the center of the projection is raself the right-point.

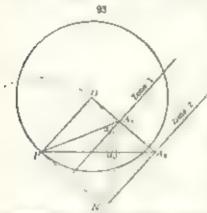
The explanation of the above method that is given as follows. In Fig. 82 let the core represents a very discount by ghith sphere. It appeared as post on an fact of V the time of the place of the gas a discount. It has not a refreser in presention of a sound place by any time with the ance of the great place of the g



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be determined to the rangings from here to this product I meaning be at the single. The point A has on the large ranging cough C center of the range of the sign of the distance A. In equal, to the Ly adverses A of the right triving a new side of which in equal to A do not the other to C of the range that handment a care so.

To measure the angle between parallel zonal lines on the gnomonic projection — In Fig. 93 let the two bies Zone 1 and Zone 2 represent two parallel noise, lines the angle between which is desired. Draw the radial line from the center of the projection, O at right angles to these sonal lines intersecting them at the points A and At Make O P at right angles to O Aids. The single A P 1, will gave the angle between the two zones. The construction will be reality understood of the figure is supposed, to be larged on the line O A, A, as c); an axis until the pract P beer new the center of the spherical project on. The broken are now represents a vertical cross section of the sphere of the spheries, projection and the points at an ting the post is where



Meson-removal of the angle between parallel as les on the Landmorte Projection

the two sonal lines cross it. The nugle at I' is obviously the angle between the two sunes.

The angle between Zope 2 and the prism zone, the line of which heat nt infinity on the guestinio profestion is given in hig this by the angle AsP A which is the same as A 1.P.

A greenette net, an dar it characfer to the a epocytaplic net described in Art 46, is useful in plot ing the points of a projection or in pack ag theastrements apon it. The straight lines up not represent the projection of the area of great direct of the splictical projection, while the hyperbols curves represent those of the small vertical areas

The guemorie projection is most commonly used in connect on with the measurement of crystal angles by means of the two-crede gomometer. This use was be explained later, see Art 237 For more detailed descriptions of the principles and uses of the grouponic projection the reader is referred to the bigrature listed below.

## References on the Stereographic and Gnomonic Projections

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Pendlet, S. L. The Stereographic Projection. Amer. Min., 5, 67–1920.

Pendlet, S. L. The Stereographic Projection. Amer. Min., 5, 67–1920.

Pendlet, S. L. The Stereographic Projection of Problems in Craphical Steady. 4, 5 m., 4 m., 4

d

ıĖ

48. Angles between Faces. The angles most conveniently used with the Miner symbols, and those given in this work are the normal angles, that is of camples between the pieces or nermals in the faces, measured on area of green errors to ring the pears as ar wa on the stere graphic projection. These merical angles are the supplements of the actual interfacial angles, as has been excusined

The relational between these sortial at gase for example in a given tone is much are pier than home exact is between the an and ter-them may be there is by an one of former, and fines in this the to be the detroit neigh between we end have a se it to he from if the origine of forces in the between the begin to the first to make the origin to the hill 7 010 pp that for a fix a 120 2 40 mat (10) A 150 and so 120 / old. The relation holds are o all the

Parthermore, d will be seen that a prossing and log in in a Votes about days as a repeat of a speak of the state of the same

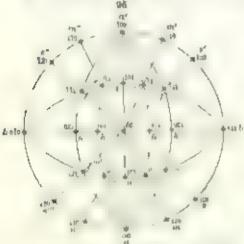
The or are light a factor angle 10. It was by hary Chrysolite of the original the angle 11 A I are und 010 A 11 for the content of the angle 11 A I are und 010 A 11 for the content of half the angle 111 A 111, or")

Here an items; titles work too ago A is used to require the angle between two

faces, socially designated by to term

49. Use of the Stereographic Projection to Exhibit the Symmetry. symmetry of nav one of the crystal me casses may be really exaliated by the boly of the scereage of a projection

The axes of binary, argumal terragonal and hogogonal symmetry are pig respiring respirelisms by the following might

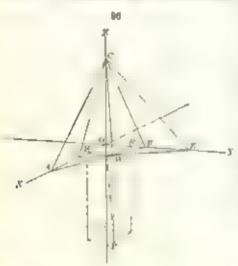


Sterrographic Projection of his swim Chrysolite Cryman, Fig. 34



Further a plane of sympostry is a presented by a full me zonecircle, while a defined line in hicates that the plane of symmetry a war tipic. The position of the crystal egraphic axes a shown by agrows at the extrematics of the The pole of a face in the upper half of the crystal (above the plane of projection) is represented by a cross; one below by a circle. If two like faces fall in a vertigal gone is death a sign is used, a cross within the area Figs 109, 146 158, etc. give thastrut ons

50. General Relations between Planes in the Same Zone. (crimin important relations on so between the college of faces that he in the same zone. If the reduces of two faces is ug in the same zone are a bled to each other, the can wal be the indices of a face only between them, or in other words a face that truncates the edge between them. Note in Fig. 94 that the indices of c can be obtained by saiding the indices of d and f, 101 + 121 = 222 or 111), also by adding the unities of m and r (110 + 001 = 113), etc. All faces to belong to the said wone, indictional force as they are called mass have their mutual independent as partial to a given direct at see Art. 43. This direction is known as the axes of the same. The position of this same axes can be expressed by what as known as the same some r. Consider

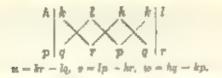


I to 90, whope are represented two ery and faces 4 Ht and CDE, nfreeering the crystallogs plan cons A. ) and Z In the class ration. for suppliedly, both faces have been specimed to mass through the point Cast the axis Z. Thus of course, is possible since any errors plane one be moved parellel to result s hold after ig for realise in tercepts on the crystm axes. It so two pares intersect in the and C-B', which then becomes the direet in of the sonal care for the sour in which they be Let the line O P which have been drawn parallel to this circuit in represent that axes. In the paral depresel if which it is a diagon, the length of the edge () A at the pure to matte have been basen as equal to the distance O-C. The pulpt P

on the zond axis and therefore the direction of the axis itself is fixed by the three moral axis is if M is home to S. By means of the consideration of single tribate as if a possible to prove that the values of these coordinates may be expressed by,

$$O(M - (kr - lq)a) O(R = (lp - hr h, t) S = (hq - kp)c$$

where a,b,c is present the unit lengths of the three creatile graphic axes, A, B, Z and bkt and pqr) is pose—the iteres of the two sees ABC and CDE. These expressions are unitary simpleted by substituting a = kc. Ly, c = kp + br, c = kq - kp, giving O(M) = aa, O(R) = b and O(R) = ac. The three figures (seed are seed to be the symbol of the action in question. That represent the recipies an of the comes of the three coordinates, or in other whose are the indices of a point P or the zond axes. They may need reachly be of threed by a system of cross-enditry categories. They have need to be of the following solver. With the values of one feet twee in their proper order and length under them the corresponding to the following solver. With the corresponding collection of the fact and lengths and last number of tach a ries. If on multiply the lightness p and p are cross-area see to p, and subtract the product of the two pointed by p and p are cross-area see to p, and subtract the product of the two pointed by p and p. The three numbers obtained will in their order correspond to p, and p.



Since the zonal symbol for a given zone may be branced from the indires of any two faces lying to that zone it for any that to be indicased avery possales face in that some most have being only tongs to the gone symbol. For is given here with in least again to a some here ag the symbol query the followare equation, known as the sonal equation, must had true,

$$ux+vy+ux=0.$$

In this way it can be readily shown whether or not a given face can be in a contain some

Further if Land be the symbol of one some and effect at of another interaret, gut, then the point of intersect in wil. Janua be the pare of a possible erysen, face I a indices hill, mean satisfy the equations of lath somes and may be old aned by combining them or the same result may be built by taxing the syn tiols of the two genes, and sul pecturg them to the same sort of crossthus placed on by which they were then serves or amaly derived

61 Exemples of Zones and Zonel Relations. The filtering are react to which the piped en a se second one. In high of the figure of section of section of section (19), 6 of 9) for a very against the arrivage but the standard of the same without the first the standard of the same without the standard of the same without the same witho

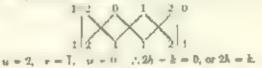
Agong the faces of the continuents of the meritantal and being parallel to the horizontal have a thorough the more will be used the transfer of the party of the

the i a reme is being earn to the name I so that he ill

the transfer of the transfer of the thirty of the state o

The mass still, all to a light need by the still again again and still a light the grant and again and the still are the still a for he of a the each of new source a current that there is a conscious ratio of the horizon is vertical in of a to a the is been. For one four a may be the wit that h = 1 or the en it I thin 25 k

A the of A and the stidings be at a small at since right his above extense. For example for the faces  $s_i(1,3)$  and f(s,4), the schema gives



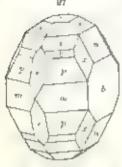
The souls I of a face hang at once to his comes as stated above, most satisfy the armal equal a of a b the ast a note to a comin the set of the continuing the equations of by a who in the continuing the equations

for each ple we bug u, of selphor the facelestered z is in the Zone in with 50010 and 5,113, a so is Zone 2 we b perfet and -- 11. These mores give, respectively



Histor for 1 the small engatem  $\mu$  is  $\lambda = 1$ , but 2 k = 1, a substitute three, we detain A = 1 A = 3 A A B Face with therefore 133

The same result is given a grown grown in grown as the sonal symbols Oil, 301, together after the some mection, chair



Salphur



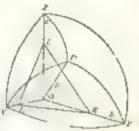
Heth. v. agasts 2 = 133

If a notice of oil case usion belongs to oil the different systems. In the many we are the own in there are for more one of the three referring to be force tall uses of any the there, to up then when the some reuseons are applied. See Art. 170.

62. Methods of Calculation. lo general the angles but seen the poles can be extende ed by the methods of spherical riginometry from the crungles shown in the

apheren, projection which for the most par, are right angled forting fundamental reart the counset the exes with the elemental angles of the preeset is the most in pretrant of these are given under the many-dust systo as Some genera relations only are explained Eyend'd-

63 Relations between the Indices of a Plane and the Angle made by it with the Axes. In Fig. 98 at he live bees, X 1, and Z represent three erys a lagrapour axes making any angles with each of ar and let a but I congressed their unit lengths. Assume the face HKI out ing these loves with the intercepts Or H, O K and O L. Let O p P be a home to the paine II h I, intersecting the plane at I and the enveloping surface of the sprened one posts that P. The has represent been seen of the



grate form. Space to man to pass to mand to the plane HKL the triangles 110p. KOp and LOp are righ ang is and the following reactions hold true

$$\frac{Op}{OH} = \cos HOn = \frac{Op}{OK} = \cos KOp$$
,  $\frac{Op}{OL} = \cos kOp$ 

The rigles HOp, KOp and LOp are equal, respectively, to the angles represented in the spherical projection by the ares PX, PY, and PZ and  $QH = \frac{0}{h^4}$ 

 $OK = \frac{\theta}{\nu}$ ,  $OI = \frac{\epsilon}{I}$ . By substituting we have,

$$-D\mu = \frac{a}{b}\cos P \setminus -\frac{b}{b}\cos P Y = \frac{r}{l}\cos P Z$$

The equation is him limited al, and severa of the relations given beyond are deduced from it.

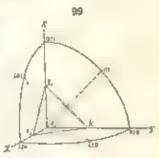
The most self displication is that when the axis, angles are 00° as represented in Fig. 29 turn 1 7.7 are the temperature 00. 01 00. respect of a Also if the plane lift is taken as a face of the last pyramid, that is, it is intercopus on the axes are taken as the talt lengths.

$$OH = a$$
,  $OK = b$ ,  $OL = c$ 

Then the burs HA HI KI gave also the intersectional the shares 100 to 011 on the three axial phases, and their who are recent the same fixed a normals to these one rown from C I will be obtained but that figure, then, that she find allowing relations hold true

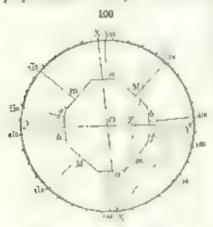
tam (100 
$$\wedge$$
 110) =  $\frac{a}{b}$ ;  
tam (001  $\wedge$  101) =  $\frac{a}{a}$ ;  
tam (001  $\wedge$  011) =  $\frac{a}{b}$ .

These values are often used later



54. Cotangent and Tangent Relations. In the case of four forces in a zone concerning which we know exter the angles between all the faces and the manes of three of them, or the angles between three faces fall in the interest in its possible to either a sample graphics, method of plotting or by gardient in the contrained florings and or indices

To illustrate the grapher method first in Fig. 100 represent a cross sect of perpetit what to the prists gone of a rhod-state crystal. The traces upon the



plane of the drawing of the faces a(100) and be 10 provide the chreetien of the bars of reference \ ano } It is assumed that the post in of the third face milled, is known and a line lown parallel to its trace upon the plane of the Irawing from the point X will give ats relative intercepts upon the two lines. of reference. These intercepts do not correspond to the unit lengths of the axes a and b same, thod the being inght is these axes do not be in the la me of the drawing but they represent rather the unit lengths of bese axes as foreshortened by projector upor tast plane. The makes in Merence Lowever since it was still be true but an tones I me to the prism zone of reach a timest at the

cept these two lines is distances what with have rational relations to be lengths of the intercepts of n. It is now assumed that a morth free l has the indices l30 and is include posit in a respect a by what l case in the zone is required. From its indices—it us in except the two bias of reference  $l \in X'$  and  $l \in I'$  in the ratio of l to l the l equal l on l l1. Then a has paring these two points will give the direction of the trace of l upon the paint of the rawing and so determ be the angles a will tasks with the other faces in the zone.

If, on the other hand the angles between f and the other faces in the sone were known, the position of the trace of f upon the plane of the drawing could be found and so its relative intercepts (and in hies) upon

the two axes of reference be determined

101 R

If the method of a random is used at F,Q,S and R to the point of force of a zero A by F , taken L such an order that FQ < FR and so, the unitsees of those from in respectively

P Q R 8

Then it may be proved that

where

If one if these fractions evalues to be indetermined from a distriction of the others

From the site of charity a new to the reconstruction with the fire and remain one patron a second contract to applied to prove a compact

The cotangent relation becomes truth simplified for a recting flar zone, that a a zone is tweeth a processed and a face by the in a zone is right in gles to a so that the right becomes  $90^\circ$ . In fig. 16 the I bit in  $Q_{I}p_{I}^{\prime\prime}$  be two faces lying in the zone between at  $100^\circ$  and I of the with an angle  $a \wedge d = 90^\circ$ . Let Pa and Qa represent the rights between he two faces and the pracons a. Then he following holds rule.

$$\frac{h}{p} \times \frac{\tan P_0}{\tan Q_0} = \frac{k}{q} = \frac{1}{r}$$

or if the faces P and Q be in zones with the other pinneods 5 010). It could be expression becomes

$$\frac{h}{p} = \frac{k}{q} \times \frac{\tan Qh}{\tan Qh} = \frac{l}{r}$$

$$\frac{h}{p} = \frac{k}{q} = \frac{l}{r} \times \frac{\tan Pe}{\tan Qr}$$

To the apparentian of this processes as essent a trial the places of all a trial in the proper order as shown a none of accomplish this it is dien processes to use the indices and corresponding angles not of that but the new appeals hills, etc.

If the zone is question less between two punicoids which are at right angles to each other so that he indices of the faces P and Q become either  $\kappa(0)$  and pQ0, k(0) and pQr or 0k; and 0qr, we have

$$\begin{array}{cccc} \tan \frac{r(100)}{100} \wedge \lambda k(0) & \frac{1}{3} \cdot \frac{1}{2}; \\ \tan \frac{r(00)}{100} \wedge \mu q(0) & \frac{1}{3} \cdot \frac{1}{2}; \\ \tan \frac{r(001)}{100} \wedge \mu 0r) & \frac{1}{3} \cdot \frac{r}{p}; \\ \tan \frac{r(001)}{100} \wedge 0kl) & \frac{1}{3} \cdot \frac{r}{q}; \\ \tan \frac{r(001)}{100} \wedge 0qr) & \frac{1}{4} \cdot \frac{r}{q}. \end{array}$$

These equations are the once ordinarity employed to determine the symbol of any premater many or dome.

The most of mon and apparent application of the tangent pressure a where the positions of the Jac Second 110, 101, 411 am known, then the relation because

Aims

Thus the tanges to of angree between the base, 000 and 05, 201 at 22, 201 at an exercise to be 4.1.3 at one the largest of the angle edween 00, and 1.0.1 Again the tangent of the stage of the stage 1.00  $\times$  1.30 is twice the to get 1.100  $\wedge$  1.00  $\times$  1.00  $\times$  1.00  $\wedge$  1.0

These and relations are shown clearly in Fig. 102 which represents a reserver in some between a few and the first section in the suggests between a 101 and 101 b. It is suggested that the adoption between the faces of a district point the adoption between the faces of the positions of their point between the interpretation is interested in the beginning the first point for a new few in point A on his are researching the representation of the traces. It is necessarily in the first point in the figure of the traces. It is necessarily in a second of the traces of the traces.

TOTAL STATE OF THE STATE OF THE

10%

in the sent of the effect the measure of the first of the continuous properties to the continuous properties to the continuous properties to the continuous properties to the sent of the sent of the sent of the first of the sent of the

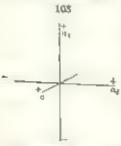
$$\begin{cases}
 \text{tan. (St. 10)} & \approx 3.61 \cdot 2^2 = 1 \\
 \text{tan. (St. 5)} & \approx 3.65 \cdot 6 = 1 \\
 \text{tan. (St. 5)} & \approx 4.028 = 1
 \end{cases}$$

Note that a simple demainstration of the no-cases saw of Maller, see Costro, Min Man, 17, 334, 1916.

## I. ISOMETRIC SYSTEM

(Regular or Cubic System)

55. The isometric system embraces at the forms which are referred to three exes if equal engines in a right angles to each other. Since these exes are right any intercharged by it is customery to design to them all by



Isomo true have-

the commonly accepted position are undy one of these axes has a vertical position and of the two which be in the horizontal position and of the two which be in the horizontal pione, one is perpendicular and the other para, at to the observer. The cruer in which the axes are reterroit to in giving the relations of any face to their as it accept in Fig. 103 by effecting them as, and as The positive and acquire radic of each axis are also shown.

There in far classes here achided of these the agree of set witch possesses the tughest degree of symmetry for the session and indeed, for all crystals, as by far the agent agreement. Two of the other

classes, the purit shedral and term earns, also have numerous representatives uniong minerals.

## 1 NORMAL CLASS (I) GALENA TYPE

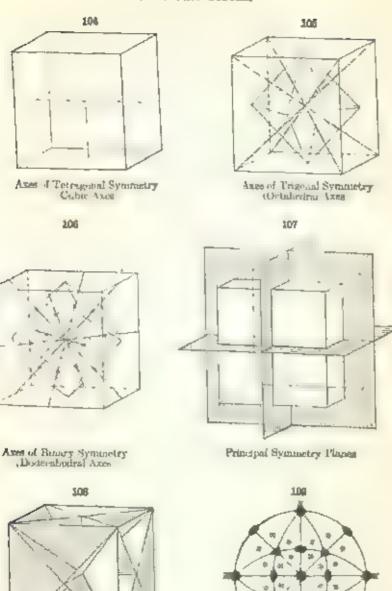
(Hesochikeuras, Halahedral or Duesseral Central Class)

56. Symmetry. 3 cl. Ax.-1; 4 diag. Ax.-3; 6 diag. Ax.-2; 3 cl. P; 6 diag. P., C.t. The symmetry of even of the types of sortis commented in the twing table, as as assumed to the class, and for the combinations, is as follows.

tree of Supermeter. There on three principal axes of tetragonal symmetry which are consider two teas error description axes and are sometimes known as the right exes of the tree teas of the second tree are fett a gent two terger deviate by which energy in the mode of the actions I man, by the other way the new mode at the new larger and the new are supermeters and the new are supermeters are perpendicular to a face of the orthogonal bandly here are say largered axes of energy symmetry which based in plane

I the mailed reserved, as before stated, a new it is the one it common and hence by fact the most in common and hence by fact the most in common and hence by fact the most in a common and hence in a common and hence in a common and hence in a common and his property in a common and hence in a common and hen

The product of the pr



Diagonal Symmetry (Tance Symmetry of Normal Class, assumetry System

angles made by the cubic axes. These are perpendicular to the faces of the dedecahedral axes. These symmetry

axes are shown a the Figs 104 106

Planes of Symmetry - There are three principal planes of symmetry which are at right angles to each other and whose intersections for the position of the crystallographic axes, Fig. 107. In addition there are six diagonal planes of symmetry which biaset the angles between the principal planes, Fig. 108.

The accompanying stereographic projection (Fig. 199), constructed in accordance with the principles explained in Art. 49, shows the distribution of the faces of the general form, hit hexoctahedron) and hence represents clearly the symmetry of the class. Compare also the projections given later

5? Forms. - The varieties possible forms belonging to this class, and possessing the symmetry defined may be grouped under seven types of south. These are enumerated in the following table, communicing with the suppossi-

		9.D413(50)
1	Cabe	(400)
	Octaliedron	111)
3.	Loriscaledron	110)
4	Tetrahexahedron	hk0 us. (310), (210), (320), etc.
	Treoctaticizen	hhl) su, (331); (221); (232), etc.
6	Trapez-tu-trop	41) as, (311), (211), 322, etc.
7.	Hexoctahedron	hkl) as, (421); (321), etc.

Attention is called to the letters in formiv upon in this work and in Dana's System of Mineralogy 1892 to designate certain of the numeric forms. They are

Cube a Octoberated of a 210, f=210 g=320, h=410. Therefore the rest  $\rho=220$  g=331 r>12  $\rho=441$ . Therefore the form  $\rho=220$  q=331 r>12  $\rho=441$ . Hencetaberates  $\rho=30$   $\rho=421$ .

58. Cube. — The cube, whose general symbol is (100), is shown in Fig. 110. It is bounded by six similar faces, each parallel to two of the axes. Each face is a square, and the interfacial angles are al. 90°. The faces of the cube are parallel to the principal or axial planes of symmetry.

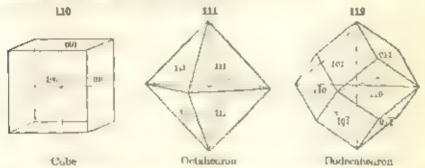
59 Octahedron. The octahearen, shown in Fig. 111, has the general symbol (111). It is bounded by eight summer faces, each investing the first excess at equal distances. Each face is an equalitieral range with plane angles of 60°. The normal interfacial angle first A Li 1 is 70° 31′ 44′.

60. Dodeckhedron. - The rhember tedecahedron t shown in hig 112, has the general symbol (110). It is bounded by tweeve faces, each of which mosts two of the axes at expan distances and as paramel to the third axes.

 The image followed here as use in the ther systems is in their each value that of Maller (1860)

The descendence of the createlegrapher is for large we be therebe alonged faces continuous, and special of given the section or oping to values and a mode near and to the createlegraphy this what is at present though the presidence approximated for it. See Art 12.

Each face is a rhomb with plane angles of 701° and 1091°. The normal inerfacial angle is 00°. The faces of the followabledron are parallel to the six naxitary, or diagonal, planes of symmetry.



If will be remembered that, while the forms described any designated respectively by the synthesis, 00 - 1 and 10 can bifure or now size of the forms has also own indicate. Thus for the cube the six faces have the indicate.

For the actahedron the indices of the eight force are

For the dadwahedron the in two of the twelve faces are

These should be carefully stoned with reference to the typeres and the models, and also to the projections is go, this take. The stones also also one there are a notice when the area where the expression is that he can give as once he minimum of any face copy red.

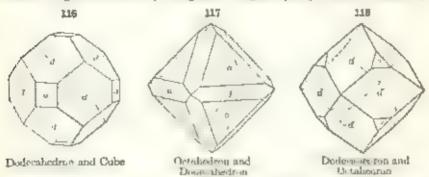
61. Combinations of the Cube, Octahedran, and Dodecahedran.
Figs. 113-115 represent combinations of the cube and octahedran, have



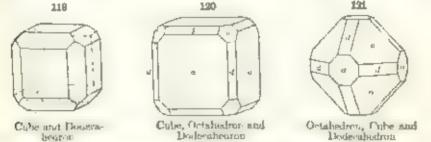
116 119 of the cube and federahedron, Figs. 117, 118 of the opt-hedron and dodecahedron, finally Figs. (20, 121 show combinate are of the three forms. The prodop it away, form, as in cube in Fig. 113, he octahedron in Fig. 115, etc. is usually said to be modified by the faces of the other forms. In Fig. 114 the cube and coefficient are sometimes said to be "in equilibrium,"

since the faces of the octahedron meet at the middle points of the edges of the cube

It should be carefully noticed further, that the ortahedral faces replace the solid angles of the cube, as regular triangles equally inclined to the adja-



cent cube faces, as shown in Fig. 113. Again, the square cube faces replace the set solid angles of the octabulron, being equally inclined to the adjacent octabulrid faces. Fig. 115. The faces of the didecahede a transcate\* the twilve same at octabular the cube, as shown in Fig. 110. They also truncate the walve edges of the octabulron (Fig. 117). Further, an Fig. 116 the cubic



faces replace the six tetrahedral solid angles of the dodecahedron, while the octaberral faces replace its eight to be businessed angles (Fig. 118).

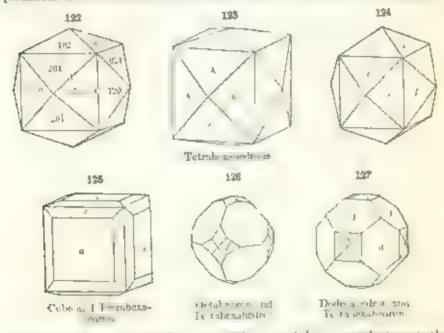
The normal interfacial angles for adjacent faces are as follows:

62. As explaines or Art 18 actual crystata a veryolless steman or less worldly from the idea sould girth consequence of the non-month of edge east of the faces which reveals, there are, is not actually the gooder of a circums of eight symmetry relatively to the laten process of the national states of the consequences of the faces of emistally an emission to the conditions of emistally graphs symmetry may make the angular position for a make faces. Again, it will be noted it in a condition of an attackly faces.

<sup>\*</sup> The words traceute transaction and undy when the modifying (are makes equal angles with the majoriest natural forces

the axes within the crystal as, for example, the note withil face of a Fig. 113. It is at a true is a very crystal the face which the mass of a metacors if produced as a same the axes are refer to the research to the axes are able to a rather referred to the axes are able to a referred to the axes are able to a referred to the axes at a referred to the axes are as a point or referred to the axes are as a point or referred to the axes are as a point or referred to the axes are as a point or referred to the axes forms and two monators and are referred to the pages belowing.

63. Tevahexahedron. The tetrahexahedron (tetrahexhexahedron) (Figs. 122-124) is bounded by twenty-four faces, each of which is a consistent fraction of Four of these faces tagether occupy the position of our face of the cube (be schedron) whence the name commonly applied to this form. The general



symbol is the the honce one face is pure also one of the uses while three tests of other two axes of unextend an increase here are either to the face of engages between a most of the key 122. The interferral argue of other times are symbol. It is given from the selection of the angles of some of the little are given on a lower selection.

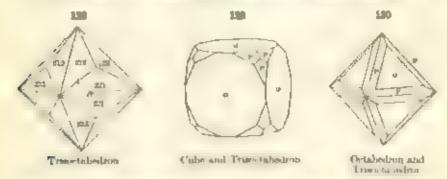
Property of a large run out of a range defines, as the ratio of the interest of a workers up tensor in the arms for example 1, to other (210), (210), (320) one. The tensor 210 is something 122 in the fig. 123, and (331) in Fig. 123. At, we territe calculous full in a zero with a charter on the description of the increases are exclusively to a the form approximate the other in which  $k = x + \log k + 1$ , which is the form approximate the other of the property explaints of the exploration of the first tensor of the special exploration of the first tensor should be carefully to each uncertainty of the special exploration good to each uncertainty to each.

The faces of the tetrahexahedron bevel\* the twelve similar edges of the cube, as it Fig. 125, they replace the solid angles of the combined in by four faces inclined on the edges of g 125, f = 310), and also the tetrahedrahem of angles of the dodecatedron by four faces inclined on the faces. Fig.

127, h = 410)

64. Trisoctahedron. The treactabedron (triakesectahedron log 128) is bounded by twenty four squar faces, each of these as an assertion triangle, and three together one by the position of an octahedral face, whence the common name it, other to distinguish it from the imperciledron or temporal transcaledren it, a sometimes called the importal transcaledron. There are two stacks of edges retired 4 and B in Fig. 128, and the interfacial argue corresponding to a her to sufficient for the determination, of the special symbol.

The general symbol is (hhl, remains forms are (221) 331, etc. Each face of the truss tandedon meets two. I the maps at a distance we than unity



and the third at the unit length or which have identical expression to a horsen to a of the exess at the mot length and the thirt is a distance greater then unity. The indices consigning to only face should be cared by post the period is external angles for some of the more constant forms are given

on a later make

68. Trapersbedron The trapersbedron's constitution (Figs. 13), 132 is tammed by twenty four it is at fives such of some a quadraterial or traperson. It also be as a appearance a certain mater, or the embedron region of the name constraints output and the traperson (constate from There are two kinds of edges, or credit and the first past. The general symbol is hill common forms are 31. 211). Also one Of the faces such entry is a distance was than moty and the other two at the material edges, or fagure on all distances on a face, to the second of the past of the material edges on the state of the material edges of the state of the material edges.

the state of the state of the territories about the state of the state

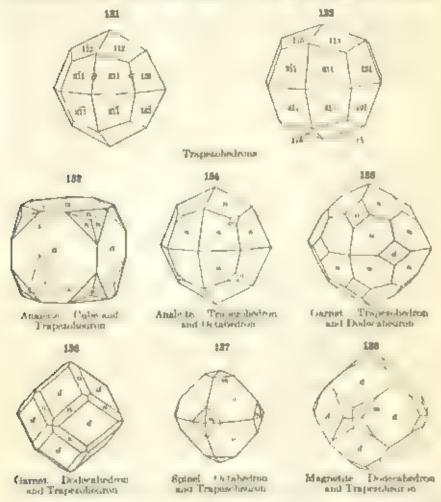
<sup>\*</sup> The ware level to small where we like them imposes the sings of a familiated become are took or a specifically a representation of a second state of a second sec

as were later that the more transmission is also given to other solids whose tapes are transmission and the transmission transmission and the transmissions.

belonging to each face should be carefully noted. The normal interfacted

arg es for some of the common forms an given in a later page

88. The combinations of these forms with the cities of the should be carefully stanted. It will be seen big. 129; that the frees of the trisoctal edron reporce the solid angles of the cube as three faces equally



inclined on the edge. this is a combination which has not been observed on crystals. The faces of the trapez-bedren appear as three estimatemagnally inclined to the cubic faces. Fig. 183

Again, the faces of the tracetabetron bevel the edges of the octahedron, Fig. 130, while those of the trapezohedron are trungler included to the faces at the extremules of the cubic axes, Fig. 137, m<sub>1</sub>3.1, Stal again, the faces of the trapezoleda a n(211) trapeate the edges of the dodecahedror (110), as shown in Fig. (36), this can be preved to force at once from the zonal relations (Arts 50, 52), of also bigs (4d, 144). The position of the faces of the form in (41), in complaination with a shown in Fig. 137, with d in Fig. 138.

It should be not led that the trapezet sdrop in 211 is a common form both alone and in each matrix, in 3.4 is common a relation on. The tracest tracesponding is rarray met what thought is combinate in Fig. 130, it is not

ancomanon.

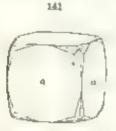
67. Heroctahedron. The heroctahedren hands tehedren, Figs 130, 140, is the get r. form in this system. I see mosely yearst eight starter faces, each it waich is a scalene triangle and each inversely, the three axes





at an equal distances. The general symbols is bkD concers forms are a 321), shown in Fig. 13 concers to the fine box 110. The enterior theory which force as shown in Fig. 130 to more fails in the properties of the 14s, 144, should be carefully standed.

The lexit of our host three kinds of edges a cond 1, B, C league, no lode, abortor in hig (3), he negles of two of these edges are recent to



Plucette. Cube and beconsidered

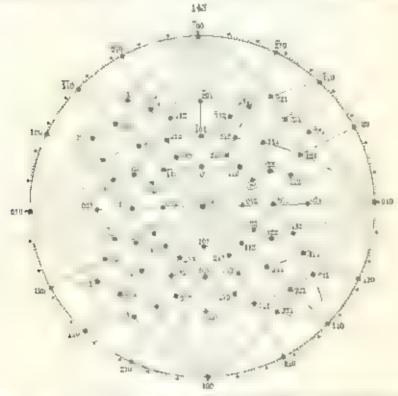


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by the symbol neless the x-and relation can be under use of . In Fig. 142 the forces of the heave the rotative the distribution x gas, and hence for this form h = k + 1, the form x has the spheric symbol . (21) The beyong a beginn along is a very rate form, but  $x \to x$  is a constitution with the cabe thing . It, the title is sex an all faces  $x \mapsto x$  and x are x and x and x and x and x are x and x and x and x and x are x and x and x and x are x and x and x are x and x and x and x are x and x and x and x and x are x and x and x and x are x and x and x and x are x and x and x are x and x and x and x are x and x and x are x and x and x and x are x and x and x are x and x and x and x are x and x and x are x and x and x are x and x and x and x are x and x are x and x are x and x and x are x and x and x and x are x and x and x are x and x and x are x and x are x and x are x and x are x and x and x are x and x are

68. Pseudo-symmetry in the Isometric System. Isometric forms, by development at the direction of the filter interests, such at a feet against forms. More commandated from the direction of the first should be dead symmetry by explosion, or by the temps, in the direction of all social edges, was a both these cases are direction that Conversely certain that believes forms resemble at some ric certain the ladded of forms resemble at some ric certain the page.

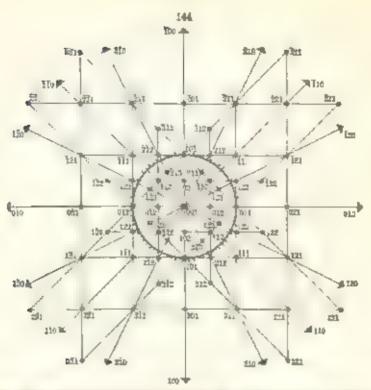
69. Stereographic and Gnomonic Projections. The a crooging late on jection, log 43, and good notice posteriors, log 144, show the posteriors



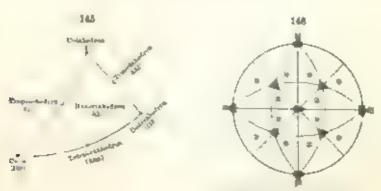
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It is proposed the first for the start of a medical HII and locked reter HO mest the torstocy tears in 250 the transcribed or 231 the traperd of content of the South meters because the first seed in 3 the transcribed and a start of the s

The tiple two car of the all ones are fell to only the an order converted by the vite of the file of the control of the contro



Gramonic Projection of Isi metric because Cabe 100 Octahedron 11 Dedecabedron Tereshevalledron 210, Trisca to tedron 221 Trapezabedron 211, Revoctabedron 221



Symmetry of Pyri obearal class

25

35 191

old 010, lot 010. Note further that the faces of a given torm are at appetrically distribaten about a cubic face, so fell, a dedecated as face, as 01, an orthogen, face, on 111 Note Casher the symbola that belong a the meanifold faces of each form, comparing

the projections with the figures which precede

time is note the toronal rate of poores for example the some between two clares are size along a dedocumental face and the buse of an posses of circumstal clares. Again, he seems from a color face on 100 the right to octale dry face and the a decirration ral are us fitt present through the traces hedrone as the 211 off, as a the creartabestrace 203 12" , 33 etc. Aim the rone from one descendents face, as 110 to me that an Ol, case og brough 121 at 322 etc. At the same more apare three towns with the as a source about a the ligares accorded dress and Action of the relations under est in Fig. 145. we be mad useful From a great that any or son fave falling to be some between by e be not distless absorbed run in the long to a ritra exalled run any face talling in the sour tentween the cube and octahescen need belong to a disposalmental as very face along in the cone between the established and I steenbergen and whose to a traditalement, author, may free facing outside those three rooms must onerg to a heavetakedron.

# 70 Angles of Common Isometric Forms.\*

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4.11

70. Angles of	Common Isome	tric Forms."		
TETEAHERAHOUSOSS.  Cf Fig. 122. 410 310 620 210 530 820 430 540	Edge A  310 \( \times 201, \text{ etc.} \)  116 45  25 501  30 37  30 52;  42 40  46 11;  60 12;  52 26;	Edge C 210 A 120, etc 6, 551 53 1/1 46 521 28 41 22 371 10 151 12 401	Angle on v 160) 14 - 2 15 - 25 21 - 48 26 - 34 30 - 57 33 - 11 30 - 52 38 - 39 39	Angle on 115 42 43 64 44 22 49 44 37 47 36 484 35 451
Triscovalizations.  CY Fig. 124032 -221 -552 -331 -772 -441	[Algo A 721 212 etc 17° 401 21 10 33 43] 77 51 40 59 43 20]	Police B 201 A 201 etc 50 A01 31 A0 31 A01 20 40 20 40	Angle on 5 130 50° 144 45 11 47 74 50 31 4 40 71 15 52	Anged on 1.4 10 15 47 19 25 1 22 0 23 20 4 25 14 1
(f Fig. (3) 411 712 311 622 211 332	Frage II 21, 7 - II rete 27 - 164 30 - 43   35 - 34 40 - 45 48 - 114 58 - 2	Edge C 211 7 12 etc 60 0' 55 504 57 241 40 201 33 84 19 45	Angle on a 160 by 251 22 0 25 141 20 291 35 151 43 28	Angle on v :11 30 1.4 52 44 29 29 25 14 49 25 11 25
CT Frg 139 321 / 42, 551 2	(3)2 es 331 A 7 154'	357 sec 321 357 357 27 27 27 10 27	201 47	ngie un Augus. 1 10 n 1/1 28 0 12 181 28 33 16 42 22 13 17 15 10

A foller art is given in the Introduction to Dans a System of Materialogy 1892, pp, ex-xuit

# 2 PYRITOHEDRAL CLASS (2). PYRITE TYPE

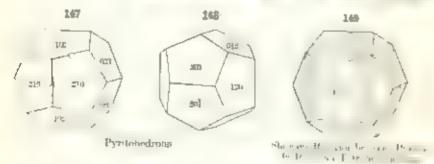
(Dyukisdodecahedral, Pentagonal Hen hedral, Diplomal, m Tesseral Central Class)

71. Typical Forms and Symmetry. 3 xl. Az-2; 4 diag. Ax-3; 3 xl. P.; C.— The typical forms of the pyritchedral class are the pyritchedral or pentagonal codecates on large 147–148, or I the I great, or dynamicologistics in large 153. The synthetry of these forms, as of the class as a while, as as I was: The three crystallographic axes are axes of bigger, symmetry only them are also four deapons axes of trigger, symmetry course, as with the octavalent axes. There are but three pitters of symmetry course, as a trigger is the parties. I the srystallographic axes and are parties to the faces of the large.

The sterocomplie projection in Fig. [16] shows the distribution of the face of the general form but diplond, and this excited he assumetry of the assumed be carefully employed with the extresponding project, a fig. 180 for the normal class is that to locar grade of symmetry are present may be then all y in aristood. In study as the runs his cross of in the first test on the first wing pages the master of symmetry expression in the control of the master of symmetry expression in the control of the master of symmetry expression in the control of the master of symmetry expression in the control of the master of symmetry expression in the control of the master of symmetry expressions.

I will be observed that the faces of noth to per shedron for 147 and the armost office that are arranged in parado pures and in this count that forms have been something bed parado pures being and the earth of an arrange that are the perfect to be taken been forms as cases a hear outsines, has type forms if and has been surely and him more up.

72 Pyritohedron, the pyriton is the 117 and throat become it is a typical form with it common species pyrite it is solid load oil



by teacher from many of all old parties ago to and an algo a light langer to a the other four sunt reages of the state of the parties of the

The general equated as bette in the children to the correction medical of the mornel class. He are except to be, right to one of the few interprets the other are mass struggered to a correction for the first terms of a period pyrite relation (250), then the terms of a period pyrite relation (250), then the terms of the com-

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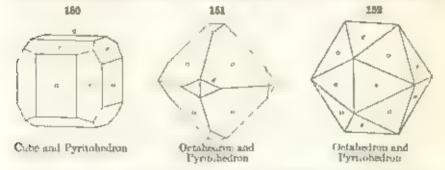
Æ,

prementary negative form\* shown in Fig. 148; the symbol is here (120)

(130), etc. (130), etc.

The positive in Linegative pyritorise rous together embrace twenty-four faces, learning the same position as the twenty-four like faces of the tetrahave restront of the normal class. The reation between the retraheranceum . I the pyrit distron a shown in Fig. 149, where the alternate faces of the tetrahecahestron mancates by shading) are extended to form the faces of the nyritahedron.

73 Combinations. The faces of the avritohodon replace the edges of the cube as she wa in Fig. 150, his resembles Fig. 119 but here the faces



make uncount angles with the two adjacent cubic faces. On the other hand, when the puritone from is morafied by the cube, the faces of the latter

truncate the longer edges of the penangons

Fig. 151 shows the combination of the pyritohedron and octahedron, and in Fig. 152 these two torins are equally developed. The resulting combinathey bears a close similarity to the icosolection or regular twenty-faced solid. of geometry. Here, however, of the twenty faces, the eight octahedral are equiliteral triangles, the twelve others belonging to the

byra-otherican are asosocies triangles.

74. Diploid. - The diploid is bounded by twentyfor amount faces, each meeting the axes at unequal distances, its general symbol is hence hall, and comthen forms are s(321 #421 , etc. The form ,321) is shown in Fig. 153, the symbols of its faces, as given, standed be carefully studed. As seen in one figure, the faces are quadrilaterals or trapezions moreover, they are grouped in pairs, heree the common name diploid. It is also somet mes called a dyakt shottenhalron

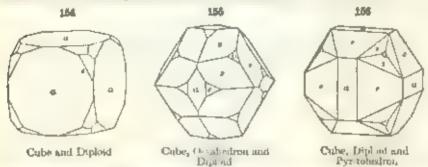
The complete entary negative form boars to the pose-Distant test form of but 133 the same relation as the negative to the positive pyritchedron. Its faces have the symbols 312, 231, 123, in the from oct at, at I smaller y with the proper negative signs in the others. the positive and begative forms together obviously subtrace ad the faces of

the nevoctale groun of the normal class. The appoint can be considered to be

<sup>\*</sup> The argo ve forms in this and summer cases have sometimes distinct latters, somet these the arrow as the postage form, but are then distinguished by a subscript accent, as e(210) and e,(120).

derived from the hexactahedron by the extension of the alternate faces of the latter and the omission of the remaining faces, exactly as in the case of the pyritohedron and tetrahexabedron (Art. 72)

In Fig. 154 the positive diploid is shown in combination with the cube. Here the three faces replace each of its sould angles. This combination form



resembles that of Fig. 129, but the three faces are here unequally meland upon two adjacent rubbe faces. Other concerns ons of the diploid with the cube, octanging in the pyritohedron are given in Figs. 155 and 156.

75. Other Forms. If the syntonedral type of symmetry be applied to panies each partiel to two of the axes, it is seen that this symmetry has for aix of these, and the resulting form is obviously a cube. This cube cannot be



distinguished geometrically from the cube of the normal chass, but it has its own or unacterate in decurar symmetry. Corresponding to this it is common to find cubes of pyrite with fine lines (striktions) parallel to the alternate cages, as unlessed in Fig. 157. These are due to the parallel of retopment of pyritoheans if case (210). On a normal of set at onar strictions, if present, must be parallel on all sets. I talges on each cubic face.

Pinte. Strated Cube Binilarly to the came, the remaining forms of this pyritchedral class, namely, 110, 110, that this, have the same geometrical form, respectively as the setal edition, dedecad edition the transmission and trapezotastic as fitte normal class. In more that the torus are there however, these torus are that at each law by the symmetry described

16 Art 71

76. Angles. - The following tall as cortain the angles of some common forms.

Pracroalthuotes

Cf Fac 147	210 Jill ele	Falge C	Angle on	Angle oa
410 5.50 910 2.0 (20 430	28° 48° 20° 52° 43° 60° 63° 7° 0 ° 7° 1 ° 7° 7 ° 44°	76° 23  72° % 60° 49  66° 25  63° 4 62° 40  6°, 10	14° 21° 16 20 21 48 21 48 26 34 30 571 33 (1)	45° 83 [° 45° 9] 61° 92 80° 14 37° 37° 80° 48°] 10° 48°]
540 850	74 30	00 44	35 .8 ] 30 48}	35 45

Γ	24	-					_
- 1	ď	л	E.	ÆЗ	a	ш	о,

	Edge 4	Edge B	Page C	Angle on	Angle on
(f Fig 153.		321 A 21 otc	321 / 213, etc.	ii 100	12a)
421 592 541 951 821	81 45 5 56 14 5 60 56 5 63 46 6 64 37 5	25' 124' 37' 61   10' 45   12' 6 31' 0	45° \$14° 35° 20° 49° 27° 4 58° 55° 4 38° 133°	26* 12: 15 47 t 32 8t 32 30 37 42	25° 64 27 101 25 131 31 34 33 124
432	67 47 72 4	43 364 22 3°1	423 3.	38 19	15 134 25 4

# 3. TETRAHFURAL CLASS (3) TETRAHEDRITE TYPE

(Hextetrahedral, Tetrahedral Homshedral, or Dilesseral Polar Class)

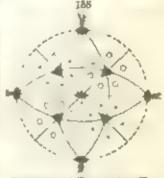
77. Typical Forms and Symmetry 3 at Ax.-2; 4 diag. Ax.-3; 6 diag. P.
The typical form of this class and that from which it derives its name, a
the tetrahedron, shown in Figs. 169-100. There are also three other distinct
forms, shown in Figs. 167-169.

The symmetry of the class is as follows. There are three ares of binary symmetry which coincide with the crystallographic axes. There are also four diagonal axes of trigonal symmetry which coincide with the octahedral

nxes. There are an diagonal prime of sym-

The atereographic projection, chig 158), anows the distribution of the force of the general form hatt, hexternhedren, and this exhibite the symmetry of the close. It will be seen at the symmetry of the close are all grouped in the aternate octools, at I the will be seen to be characteristic of all the toring pecuant to the class. The relation between the symmetry here described and thought the normal cases must be carefully studied.

In distinct on from the partichedral familia whose more were in parallel pairs, in frees of the tetrahedrou and the annigons souts are neclined to each other, and hence they are some



Symmetry of Terrahedra, Class

times spoken if as inclined hemithedrons, and the type of so-called hemithedrien here allustrated is then called one upon or retradedring her thedrien.

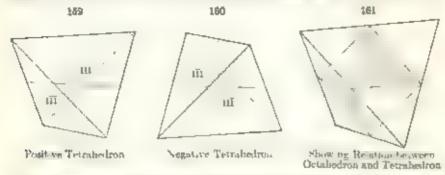
78. Tetrahedron. — the tetrahedron," as its name to discles, is a four-faced solid, be in set by planes needing the axes at equal discences. Its general symbol is (111) and the four faces of the positive form (big 159) have the symbols 111, 111, 111. These corresponds to four of the faces of the optahedron of the normal class (Fig. 111). The relation between the two forms is shown in Fig. 161.

Each of the four faces of the terrahedron is an equilateral triangle, the (normal, interfaces, angle is 109° 28° 16°. The tetrahedron is the regular

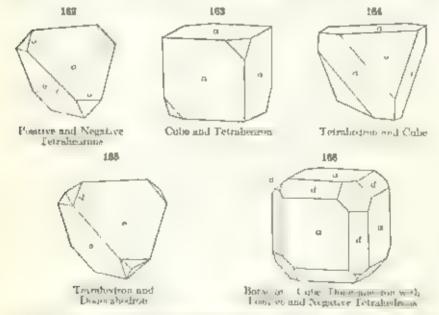
<sup>\*</sup>This is one of the fire tege of we as a groupetry with and, at two the cabe, with hedren, the rege of the lagrant with about the constitution the day two, as actually noted, are improved forms unlong crysticle.

triangular pyramid of geometry, but crystan graphically it must be so placed that he axes from the molecule points of apposite edges, and one ixis is vertical.

There are two possible tetrahedrons, the positive tetrahedron, 111, designated by the letter of which has aready been described, and the nega-



tive tetral edicat, having the same geometrical form and symmetry but the pidees of the four faces are III 1II, III, III. This second form as shown in Fig. 160, it is assumed designated by the letter of These two forms are,



as stated above, electrical in geometrical shape but they may be due aguished in many cases by the tests which serve to reveal the molecular structure, particularly the colony-figures and the my cases by pyrocectority assets in er boracete p. 335. Ar. 460. It is probable that the positive and negative tetrahadrons of splinlerite (see that species, have a constant difference tetrahadrons of splinlerite (see that species, have a constant difference).

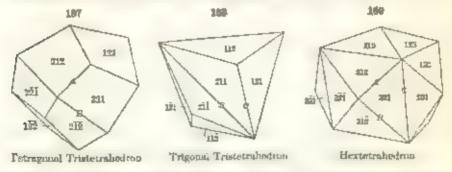
ence in this particular, which makes it possible to distinguish them on crystals

from inferent locals as and of inferent as at

If both tetran who is are present together, the form in Fig. 162 results. This is geometrically ar notal action when the two forms are equally developed, but crystallographically it is always only a combination of two tights forms, the positive and negative tetrahedrons, which can be distinguished as already a ted.

The tetrahedron in combination with the cube replaces the alternate solid singles as in Fig. 163. The cube modifying the tetrahedron truncates its edges as shown in Fig. 164. The normal angle between adjacent cube and to rahedral faces at 54. In Fig. 165 the descended in its shown modifying the positive tetrahedron, while in Fig. 165 the cube is the predominating form with the positive and negative tetrahedrons and dedecahedron.

79. Other Typical Forms. There are three other darinet types of sold son this case, having the general symbols had, old, and old). The first of these is shown in Fig. 167, here the symbol is (221, There are twelve



faces, each a quadrilateral, belonging to this form, distributed as determined by the tetrahedral type of symmetry. They correspond to twelve of the faces of the resortabedron, namely, all those fading in alternate octants. This type of solid is sometimes called a tetragonal triatetrahedron, or a deltoid dedecahedron. It does not occur atone among crystais, but its faces are observed modifying other forms.

There is also a complementary negative form, corresponding to the positive form, related to it in precisely the same way as the negative to the positive tetrahectron. Its tweeve frees are those of the trisoctahedron which

belong to the other set of alterna e scients

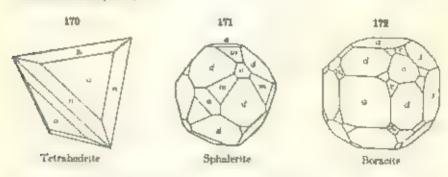
Another form, shown in Fig. 168 has the general symbol (hill) here (211) it is bounded by tweeve ake triangular faces, but buted after the type is-tranged by tetrahedral symmetry and corresponding consequently to the faces of the alternate octaons of the form his transperchastron of the normal class. This type of sold it is sometimes can ed a trajonal triaterahedron of transperchastron of the transperchastron of the transperchastron of the normal class. This type of sold it is sometimes can ed a trajonal triaterahedron of the transperchastron of the transperchastron of the normal class.

<sup>&</sup>quot;It is to be noted that the totragment tractrahedrat has been able by execuble those of the improvements a temperature of the interest to the tractral and the interest to the tractral and the interest to the imperor to the interest tractral and in the interest to the imperor because

cially with the species tetrahedrite, it is much more common than the form (hat. There is here again a complementary negative form Fig. 170 shows the positive form (1211) with the positive tetrahedron and Fig. 171 the form gui311, with a 100, o(111), and d(110). In Fig. 172 the negative

form w.(211 is present.

The fourth independent type of solids in this class is shown in Fig. 169. It has the general symbol (kkl), here (321), and is bounded by twenty-four faces distributed according to tetrahedral symmetry, that is, embracing all the faces of the alternate octants of the forty-eight-faced hexoctahedron. This form is comet mes called a heristochadron or herdinatetrahedron. The companional regulative form (hki contraces the remaining faces of the hexoctahedron. The positive hexietrahedron, r(531) is shown in Fig. 172 with the cube, octahedron, and dodocahedron, also the negative trigonal tristetrahedron v. (211).



80. If the tetrahedral symmetry be applied in the case of phases each parallel to the two axes, it will be seen that there must be six such faces. They form a cube similar geometrically to the cube both of the normal and pyritohedral class but differing in its molecular structure, as can be readily proved, for example, by pyroelectricity (Art. 450). Similarly in the case of the planes having the symbol (110), there must be twelve faces forming a rhombic dodecabedron bearing the same relation to the the geometrical firm of the normal class. The same is true again of the planes having the position expressed by the general symbol hid), there must be twenty-four of them and they together form a tetrahexahedron.

In this class, therefore, there are also seven types of forms, but only four of them are geometrically distinct from the corresponding forms of the

normal class.

81. Angles. - The following tables contain the angles of some com-

#### THE PAGONAL TRAFFFEE HARRISONORS.

Cf Fig. 167	221 A 2.2, etc.	Edge B 221 / 212, etc.	Angle on	Angle on
332	17° 50;	97' 40}'	50° 141′	10' 14'
221	27' 60	90 0	48° 1.1	10 474
552	33' 33	84 11	47° 71	19 284
331	37' 511	80 55	48° 50]	22 0

#### TRIBONAL TRIBLETHANDRONS.

ed the tee	Edge B 211 A 211 oto.	Edge C 211 A 141, etc.	Angle on a 100	Angle on
Cf Fig. 168.	281 5(1)	60" 0"	19° 28}*	35" 151 32 44
722 311	44 0) 50 251	55 60 50 35	25 144	20 29!
522 2.1 322	70 31 88 37	13 304 35 331 19 45	20 20 35 15 43 18	25 H1 19 284 11 251

#### HERTETRANDURONS.

Cf Fig. 160.	Edge A 321 A 312 etc.	321 ^ 312 etc.	221 ^ 231 etc	Angle on a: 100	Angle on or 111
531	27* 194'	57° 71	27° 59-	32" 18]"	28° 331
321	2. 471	80 41	21 67	36 42	22 124
432	16 51	62 11	15 5	42 11	15 134
431	32 121	67 32	16 68	38 191	25 4

# 4 PLAGIOREDRAL CLASS (4) CUPRITE TYPE

(Pentagonal Icontetrahedral, Plagropedral Hemshedral, Gyrandal, or Tesseral Hologrial Class)

82. Typical Forms and Symmetry. 3 zl. Az.-4; 4 diag. Az.-3; 6 duag. Ar.-2. The fourth class under the isometric system is called the piageohedral or gyroudal class because the faces of the general form (hkl, are ar-

ranged in spiral order. This is shown on the stereographic projection Fig 173, and also in Figs. 174, 175, which represent the single type cal form of the class. These two complementary souds together embrace all the fixes of the bexoctahedron. They are distinguished from one another by being called respectively rightbunded and left-handed persuage and counterwhedrone. The other forms of the case are geometrically like those of the normal class.

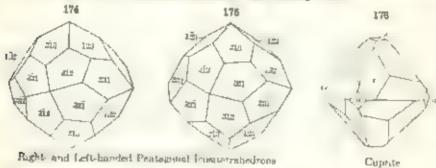
The symmetry characteristic of the class in

general is as follows

There are no planes of symmetry and no center of symmetry There are however, three axes of tetragonal symmetry normal to the outro. Symmetry of Plagiohedral Class faces, four axes of ingenial symmetry normal to

the octahedral faces, and six axes of hungry symmetry normal to the faces of the dodecahedron. In other words, it has all the rass of symmetry of the normal class while without planes or center of symmetry

B3. It is to be noted that the two forms shown in Figs 174, 175 are alige geometrically, but are not superposable, in other words, they are related to one and her as is a right- to a left hand glove. They are hence said to be enuntiomorphous, and, as explained elsewhere, the crystals belonging here may be expected to show circular polarization of light. It will be seen that the complementary positive and negative forms of the preceding classes, unlike those here, may be superposed by being rotated 90° about one of the crystallographic ares. This distinction between positive and negative forms, and between right- and left-hander chante or rp at a forms, exists also in the case of the classes of several of the other systems.



This class is rare among masseds of is represented by cuprite and sa, ammonated I is issued, shown by the distribution of the small modifying faces, or by the form of the etcling figures. Fig. 176 shows a crystal of caprite from Cornwell (Pratt, with the form \$13.10.12).

# 5 TETARTOHEDRAL CLASS (5 ULLMANNITE TYPE

(Tetrahedral-Pentagonal Doderahedras or Tesseral Polar Class

84. Symmetry and Typical Forms. 3 rl. Az. 2; 4 dag. Az. 3. The fifth remaining possible class under the isometric system is district, by Fig. 178, which represents the twerve-faced sond corresponding to the general



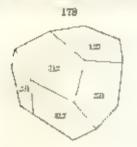
Symmetry of Tetartohedral Class

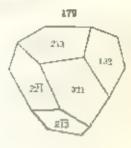
The charm attor of its fores is symbol Ast shown in the project a, Fig. 177. This form is sometimes called a tetrahenral pentraparal dedecadedron. It is seen to have one fourth as many faces as the form that in the tarmal class, hence there are four surnar solids which together embrace all the faces of the hexortabedron. These four solnes which are quantguished as right handest positive and negative, and left-handed positive and negatives are enantiemorphous, I ke those of Figs 174 and 175 and bence the sa ta crystalazing here next he expected to also show circular polarization. The remaining forms of the class are best less the cabe and the absentialecahedron the a tra-

trigonal tristetrihedrons, geometrically they are like the solids of the same annex already described. This class has no place of symmetry and no can ten of symmetry. There are three axes of limits symmetry tormal to the cubic faces, and four axes of trigonal symmetry normal to the faces of the tetra section.

This group is illustrated by artificial crystals of bartum natrate, stron-

turn nitrate, sedium chierate, etc. Further, the species ulimannite, which shows a metimes pyritohedra, and again tetrahedral forms, both baying the same composition must be regarded as belonging here.





MATRIMITE A. RELATIONS OF THE ISOMETRIA STATEM

85. Most of the and least artene in the somethic system can be solved at mice by the right-stated manager at an explain of superiors right-stated manager at any special form as

is 1 to return that the algorithm between a value face, as 100, and the adjacent face x - terrain values on, (10, 20, 30) etc. our periodical algorithm and this angle is equal to  $\frac{1}{3}$ ,  $\frac{1}{2}$ , or in general  $\frac{k}{2}$ .

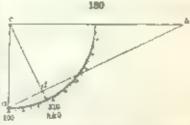
tim (Ai0 
$$\wedge$$
 100) =  $\frac{k}{h}$   
 $\frac{ac}{bc} = \frac{k}{h} = \frac{1}{2}$   
 $\frac{dc}{dc} = \frac{k}{h} = \frac{1}{2}$   
tim  $\angle abc = \frac{ac}{ba} = \frac{k}{h} = \frac{1}{2}$   
 $\frac{\angle abc}{(100)} \wedge (210)$  = 38° 34°

The relation is flustrated in Fig. 150, which also shows the method of graphically determined to the indicate of a tetrahestalectron, the angle between one of its faces and an adjacent cabe face being given.

and the forms of a green ser and a ser affect species to a some angles be tables of many a read a green to any set if

there and published to give their be come in est thanks there is not be in the control of a few many of a transfer of the first and grown in the falls many and the first and grown in the falls many and the first many and the first many and the falls many and t

85 Formulas. 1 The costone of the pole of the form he is not a see of give to be opinion on the new deep first he seem to see one of the opinion of the seem of the opinion of the seem of the opinion of the seem of the opinion of th



here or esteems adopt of much strephilication in the various special cases, for taken

$$\cos^2 f^2 q = \frac{h^2}{h^2 + L^2 + L^2} + \frac{h^2}{h^2} + \frac{h^$$

(2) The distance between the poles of any two faces Pittle and Quper is given by the following equation, which in special cases that also be more or less unighted.

$$\cos PQ = \frac{hp + kq + lr}{\sqrt{h^2 + h^2 + f^2 + f^2 + r^2 + r^2}}$$

(3) The calculation of the supplement interlocal or normal augles for the several forces into he accomplished as follows:

Transitude of the ungles A and B are, as select, the supplements of the interfacial angles of the edges letterso as in Fig. 128.

$$\cos A = \frac{h^2 + 2hl}{2h^2 + l^2}, \qquad \cos B = \frac{2h^2 + l^2}{2h^2 + l^2}$$

For the tetragonal-trustetrahadron (Fig. 1t? ,  $\cos B = \frac{h^2 - 2nl}{2h^2 + h}$ 

Trapezulactron Fig. 131) B and C are the supplement angles of the edges as lettered in the figure.

$$\cos B = \frac{h^2}{h^2 + 2l^2}, \quad \cos C = \frac{2hl + l^2}{h^2 + 2l^2}.$$

For the original-trialetrahedron (Fig. 168.,  $\cos B = \frac{h^4 - 2P}{h^4 - 2P}$ 

Tetraherahodran (but. 122)

$$\cos A = \frac{4^3}{h^3 + k^3}, \quad \cos C = \frac{3!k}{h^3 + k^3}$$

For the particular (Fig. 147), one  $A = \frac{h^2 - k^2}{h^2 + k^2}$ ,  $\cos \ell = \frac{hk}{h^2 - k^4}$ 

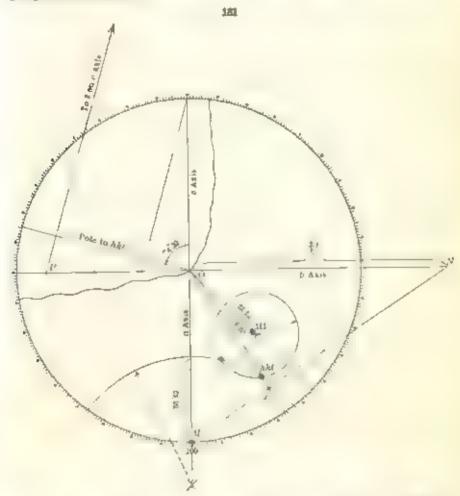
Hemetahedron (Fig. 140).

$$\cot A = \frac{h^2 + 2kl}{h^2 + k^2 + l^2}, \quad \cot B = \frac{h^2 + k^2 - l^2}{h^2 + k^2 + l^2}, \quad \cot f = \frac{lhk + l^2}{h^2 + k^2 + l^2}$$
For the diplinal (Fig. 159), 
$$\cot A = \frac{h^2 + k^2 + l^2}{h^2 + k^2 + l^2}, \quad \cot f = \frac{kl + th + hk}{h^2 + k^2 + l^2}$$

For the depleted (Fig. 189), 
$$\cos A = \frac{4^3}{h^4} + \frac{k^3}{h^4} + \frac{\ell^3}{h^4} + \frac{\ell k^4}{h^4} + \frac{h^4}{h^4} + \frac{k^4}{h^4} + \frac{h^4}{h^4} + \frac{k^4}{h^4} + \frac{h^4}{h^4} + \frac{h^4$$

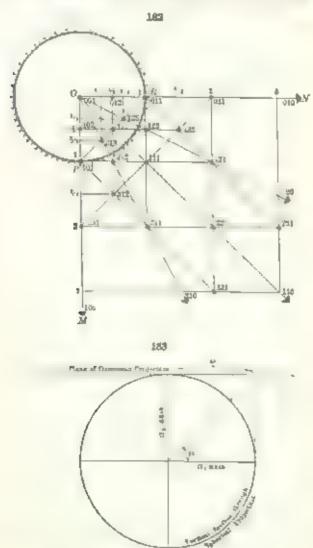
For the hestelrahedron (Fig. 100), 
$$\cos B = \frac{h^2}{h^2 + h^2} \frac{2h!}{h!}$$

87. To determine the indices of any face that of an isometric form, given the posithat of its pote on the stereographic projection. As as a serial we example of this product the hexoritation run 3.1 has been taken. It is seen used that the nights 120 \times 32 = 36° 42' and 131 \times 321 \times 22° 12° are given. The methods by within the peaces pule is located from these measurements have been desertive. It juge 53 and are if strated to Fig. 181 Having speaked the posts his a one or cawn through it tree the center C of the projec-tion. This line O P represents the interpest in with the normalal plane which is the pione of the horizontal cristia, acre, is no 15, of a plane which a normal to the ervetal face The Since two pinner worth are at right imposite each offer will intersect a third plane an agree that are at right in give to each other it I make that the pin, e of the beste adjusted in once that are at right in give to each other it shows that the plan e of the bestocalpeled for we interest the pane of the horizontal axes on the act right angues to (2.4°) if there is no the distance (2.4°) if the taken as topicer ling on on the act and the ease M-P-A be drawn at right in give (0.4°) be a time to be a will represent the processor the processor the position of the three in question upon the coarse. Only is one of a time case to be 40° M a value. The interest upon the two bosts out in ease are, therefore in to. The plotting of the interest upon the coarse is shown in the upper off band and admit of the figure. The angular distance from O to the root axis is inconsistently the agercages. It processors as Has page as there and all from the base representing the class and the late representing the pole his wateren. The listance to P is transferred from the lower part of the figure. Then we can convicted the right triangle, the vertical safe of which is the c axis, the horizontal use is that one O F the interestion I the same which is normal to the crystal face with the horizontal plane, and the hype frequence is a line lying in the fact and therefore at right angues to the pole of the face. This one would intersect the caxis at a distance equal to 30. M. The same relation may be shown by starting this last size from a point on the c-axis which is at a distance it in the center of the figure erous to  $t \in M$ . In this case, by a tracery, as the horizontal one  $t \in P$  would be at one therefore the total length. He these constructions the parameters of the face in question are above to be 10,  $\{0, 3c, \text{piving}\}$ ,  $\{21\}$  as its indices.



88. To determine the indices of the faces of asometric forms, given the positions of their potes on the gramoust projection— is an absence we example of this parametric power right-hand quartonic of the gramoust projection of examples forms, Fig. 14 has been taken and represent as Fig. 182—the res to M and to A are at right angles to the form who represent the horsestal existing that it axes a, and is. If from such other are not other as are drawn projection due to those we are not become the if we seem that the a encourse and specific existing the first projection of the same of the sam

43° point of the projection must  $v_0$  at the unit length of the exest. That this is true is true by seen by the confinemation of Fig. 183. The occurrents of the ones from the offerent point to the lines of M and O. North from the value of the lines of M and O. North from the statement of the lines of M and O. North from the statement of the Miller indices of any face represented, it is may no essay to



take the intercepts of the two lines from from its pole uson the two cases a and a place those manuscra's hear proper order and are a I as a three figure on a time of accessance theorem from the past of except the axes of both and be a which gives he expression I \( \frac{1}{4} \), which, appear, on clearing of fractions, yields 312, the indices of the face in question. If the case

of a face parallel to the vertical and the pole of which has at infinity on the gangionic projection too hibrer appy with the point of the round that that points to be we can of the rule and are pany perpendiculars to be use express tog the two numbers of the requires induce when the third is miler was sense and be 0.

### II. TETRAGONAL SYSTEM

89. The tetragonal system includes all the forms which are referred to three gags at right anges to each other of which the two horizontal exes are equal o each other in length and interchangeable and tor third, the vertical axis, is citias at rist or anger. The b rizonta axes are design mated by the letter at the vertical axis by close hig. 154) The length of the vertical time expresses properly the axial ratio of a -c, a being undertoor taken as equal to unity. The axes are crientated and their appointe en is designated by plus and minus sams exactly as in the case of the isometric 43 Section

Seven classes are embraced in this system. Of these the normal class is common and important among minerals, two others have several representarives, and another a single one only. It may be noted that in four of the chases the vertical axis is an axis of tetragonal symmetry, in the remaining

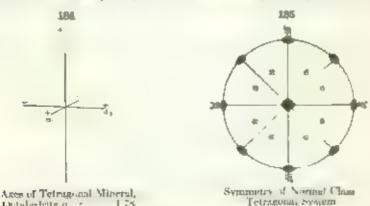
three it is in was of binary symmetry only

Octabelette a -

## 1 NORMAL CLASS (6) ZIRCON TYPE

(Intetragement Depyramidat, Holehedral or Intetragemal Equatorial Class)

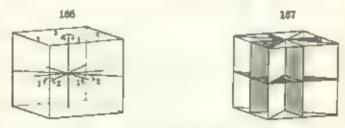
90. Symmetry, Vert. Ax.4; 4 hor Az.-2; hor P; 4 vert. P.; C The forms belonging to the normal class of the tetragonal system (cf. Figs. 188 to 210, have one principal axis of terragonal symmetry (whence name of



the system which cornerdes with the vertical crystal, graphic axis a. There are also four horizont it uses of limary symmetry, two of which comple with t. horizontal crystallographic axes while the other two are dangeous axes beseating the angles between the first two.

Further, they have one principal plane of symmetry, the plane of the horizontal crystallographic axes. There are also four vertical planes of symmetry which puse through the vertical crystallographic axes and make angles of 45° with each other. Two of these at er planes include the borroon at crystallographic axes and are known as axia, planes of symmetry. The other two are known as diagonal planes of symmetry.

The axes and planes of symmetry are shown in Figs. 186 and 167.



Symmetry of Normal Class, Tetragonal System

The symmetry and the distribution of the faces of the general form, hid, as shown in the stereographic projection, Fig. 185

91. Forms — The various possible forms under the norma, class of this system are se follows:

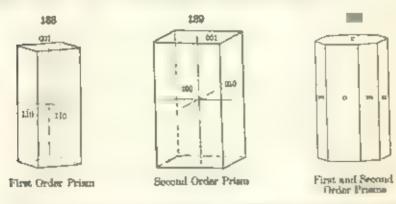
		Symbols					
2 3 4 5 6	Base or basal pranced Prism of the first order Prism of the second order Diterragonal prism Pyramid of the first order Pyram d of the second order Diterragonal pyramid		(h0t)	88, 88,	(310) (223), (203);	,216, (111), (101);	334,, etc., (221), etc., (201), etc., (122), etc.,

92. Base or Basal Pinacoid. The base is that form which includes the two similar faces which are parallel to the plane of the horizontal axes. These faces have the indices 001 and 001 respectively into an "sipen form" as they do not include a space, consequently this form can occur of it in combination with other forms. Of Figs. 185-191, etc. This form is always lettered c in this work.

93. Prisms. — Prisms in systems other than the isometric have been defined to be forms whose faces are parallel to the vertical axis of of the crystal, while they meet no two borezon axes in this system he four-faced form whose planes are parallel both to the vertical and one horizontal axis is also called a prism. There are hence three types of prisms here included.

94. Prism of First Order. The prism of the first order melades the four faces which, while parallel to the vertical axis, meet the horizontal axis at equal distances, its general synthetic remembershy 1100. It is a aquare prism, with interfaces, angles of 90°. It is shown a combination with the base in Fig. 188. It is and only designated by the letter of. The indices of its faces, taken in order, are 110, 110, 110, 110.

96. Prism of Second Order. —The prism of the second order shown in combination with the base in Fig. 189 includes the four faces which are parallel at once to the vertical and to a horizontal axis. It has, therefore, the general sumbor 100 — It is a square prism with an angle between any two adjacent faces of 90°. It is uniformly designated by the letter a, and its faces, taken in order, have the indices 100, 010, 100, 010.



It will be seen that the combination of this form with the base is the

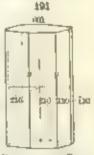
analogue of the cube of the sometric system.

The faces of the prism of the first order truncate the edges of the prism of the second order and energers. When both are equally developed, as in Fig. 190, the result is a regular right sided prism, which, however, it must be remembered as a combination of the distinct forms.

It is evident that the two prising described do not differ geometrically from one another, and furthernotes, in a given case, the symmetry of this

these above setter to be made the first order, and the other the second order prism according to the position assumed for the horse and axes. If on crystals of a given species both forms occur together equally developed for, on the other hand, separately on different crystals, and without other faces than the base, there is no means of te ling them open, unless by minor elameteristics, such as structure or other markings on the surface, ordings, etc.

96. Ditetragonal Prism. The distragonal prism is the form which is bounded by eight our air faces, each one of which is parallel to the vertical axis while precing the two borisontal axis at unequal distances. It has the general symbol (180) It is shown in Fig. 191, where (180) = (240)



Ditetrageme Promi

<sup>•</sup> In Figs. 188–191 the dimensions of the form are made to correspond to the amount sength of the verteen same better - 1.75 mm in ornshed: here forms, while the laterapulation of however, that in the case of set in crystals of these forms, while the tetragement etc. In assault intensited by the in the physical chance of the face of as compared with the faces, we set, in the vertical presents while no to seemed out to drawn as to the relative length of the vert as made. This has can be settlement, they we can a pyramic in present, it is faced for the species when a particular pyramic is chosen as the fundamental or unit form, as explained later.

The successive faces have here the indices 210, 120, I20, I10, II0, II0, I20, I20, II0

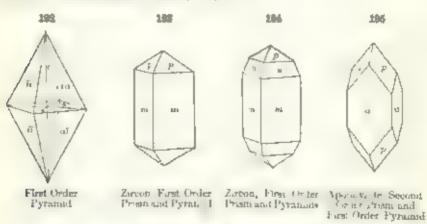
In Fig. 203 a combination is shown of this form ty=310) with the second order prism, the edges of which it hereis. In Fig. 207, h=210) it bevels the edges of the first order prism m. In Fig. 208 (t=3.0, t) is combined with

bech pure of prising

97 Pyramids. There are three types of pyramids in this class, corresponding respectively to the three prisins which have his seen described by these is stated, the type pyramid is given its systems other than the issuesting to a form whise planes meet all three it the issues, in this system the fight whise planes meet be axis class one horizontal axis white paradiction the other is also called a pyramid. The pyramid is a class are strictly

comile typicals bepresents or departments of some with est

98. Pyramid of First Order. A pyromid of the test or letter is a form whose eight sometime faces interset, the two hor zon all axes at equal distances and also interset. The vertical axis. It has the general symbol, the little a symbol pyromid with equal interfacial angles over the error of edges, and the faces replace the horizontal or basal, edges of the first order prism and the small argles of the sec of larder prism. If the rate of the vertical to the little of a given first order pyromid is the assumed axial rate for the species, the form is called the fundamental form, and it has the symbol the as in Fig. 192. The indices of its faces given in order are Above 111 [11], [11], below 111 [11], [11], [11]



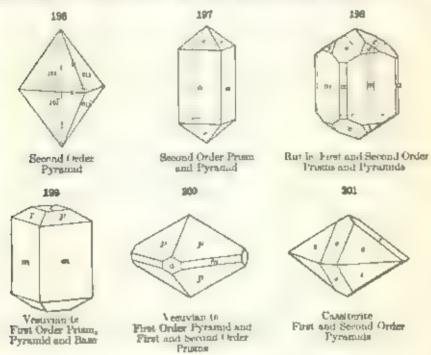
Obviously the angles of the first order pyrame i and hence its geometrical appear vary we six with the length of the versus. In Figs. 492 and 200 he pyramids shown have a both cases the sym a i 4111 but a the first case the absolute i = 1.78, while in the second variety date i = 0.04

For a given species there may be a an ber of first order p rainets, varying to position according to the table of the interce, is apen the vertical and horizontal axes. Their sturbous passing from the base 00 + m the order prism. Lit., why has be 011 + 111 + 22 + 411 + 332 + (221) + 441, see In the general symbol of these forms  $b h_0$  as a domination the form a, proximates more and have nearly to the base  $000 h_0$ , for which h = 0,

as h increases, the form passes toward the first order prism. In Fig. 194

two pyramids of this order are snown, ptilly and a 3sti-

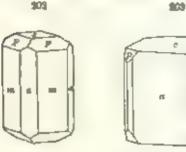
99. Pyramid of Second Order. — The pyramid of the second order in the form Fig. 1.65 whose faces are parallel to one of the horizontal axes, who e meeting the other two axes. The general symbol is (60). These faces replace the basal eages of the second order prism. Fig. 197, and the solid angles of the first order prism (cf. Fig. 199). It is a square pyramid ance its basal section is a square, and the interfacial angles over the four terminal edges, above and below, are equal. The successive faces of the form 101, are as follows. Above 101, 011, 101, 011, below 101, 011, 101 011



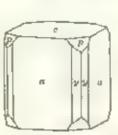
If the ratio of the intercepts on the horizontal and vertical axes is the assumed axial ratio of the species, the symbol is (10t) and the form is designated by the letter  $\epsilon$ . This ratio can be deduced from the measurement of either one of the interfacial angles  $\beta$  or  $\epsilon$  Fig. 196) over the terminal or has all edges, as explained later. In the case of a given species, a number of second order pyramids may occur, varying it the ratio of the intercepts on the axes  $\alpha$  and  $\epsilon$ . Hence there is possible a large number of such forms whose symbols may be for example, (104-(103), (102), (101), (302), (201-(301), etc.). These mentioned first color nearest to the base (001), those last to the second order prism (100), the base is therefore the limit of these pyramids (h0t) when h=0, and the second order prism (100) when h=1 and t=0. Fig. 204 shows the three second order pyramids  $\alpha(105)$ ,  $\alpha(101)$ ,  $\alpha(201)$ .

A second order pyramid truncating the pyramidal edges of a given first

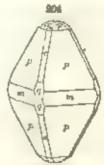
order pyramid as in Fig 201 has the same ratio as it has for A to L. Thus 101) (runcates the terminal edge of 111; (201) of (22.), etc. This is obvious because each face has the same position as the corresponding edge of the other form (see Fig. 20), when s = 111 and s = 101, also Figs 204, 209, where r = 115 u = 105) Again, if a first order pyramid truicates the



Vegavantate First and second Order Priame, First , byter Pyramid and Base



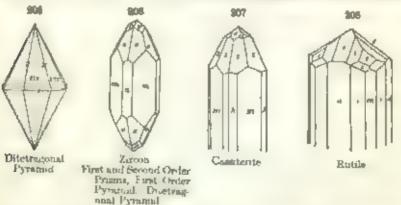
Apoplied te Secous Order Prium, Ditetrappedal Fram, bret Order Pyramic and Base



Octahedrite Two First Order Pyram to butt Orner Prison. Three Second Order Francis and Base

pyramidal edges of a given second order pyramid, its ratio for h to l is half that of the other form, that is, (112) truncates the pyramidal edges of 101. (111 of 201 etc. This relation is exhibited by Fig. 204 where p(111) truncates the edges of q(201). In both cases the sonal equations prove the relations stated

100. Ditetragonal Pyramid. - The di etroponal pyramid, or double eightsided pyramid, is the form each of whose axteen similar faces meets the



three axes at unequal distances. This is the most general case of the symbol (akt) where a k, I are all anequal and no one is equal to 0. That there are mateen faces in a single form is evident. Thus for example, for the form (212) the face 212 is similar to 122, the two lateral axes being equal (not,

however, to 221) Hence there are two like faces in each octant. Similarly the indices of all the faces in the successive octants are, therefore, as follows:

Above 212 122 122 212 212 212 122 212 Below 212 122 122 212 212 122 122 212

The ditetragonal pyramid 212, is given in the above example instead of the 21.) form because it has in the and pyramid sone between the first

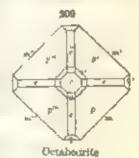
210

and second order unit pyramids, (111) and (101), and its indices are to be obtained by the addition of the indices of these two forms, as (.11) + (101) =

(2.2

This form is comin in with the species zircon, and is beare often called a zirconoid. It is shown in Fig. 265. It is not observed as i.e. shough sometimes, as ii. Figs. 206 (x = 311) and 207 (x = 321), it is the pred maintaing form. In Fig. 208 two distringuish pyramids occur, namely, h313, and  $x_0^2$ 321.

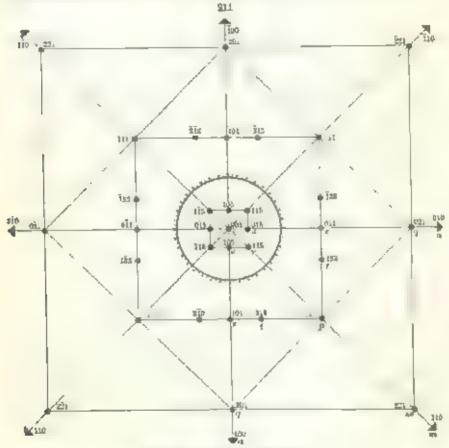
101. In addit on to the perspective figures already given, a lossed projection (Fig. 209, is added



ili 130 išz ė ītā. 911

Stereographia Projection of Octahedrite

of the crystal of optaneorate already referred to Fig. 201), also stereographic (Fig. 2.0) and graph at Fig. 2.1) project one of the same with the faces of the forms to 221 and (-313) added. These exhibit we the general reducions of the norm a class of the cotrage onless term. The symmetry here is to be a ted, first with respect to the same bar zeros 100 and 101 and 010, 001, 001, also to the state pair of similar genes, 110, 001, 110, and 110, 001, 110.



tenumente Projection of Octabedrita

# 2 HEMIMORPHIC CLASS (7) IODOSUCCINIMIDE TYPE

Ditetrogonal Pyramodal, Holohedral Revansorphic, or Diletragonal Polar Class,

102 Symmetry Vert. At.-4., 4 vert. P.— This case differs from the normal cases in having no horizontal axes or plane of symmetry, hence the forms are beaming plane as defined in Art. 28. It is not known to be represented among numerals, but is shown on the crystals of indesicenamide.

Its symmetry is illustrated by the sterrographic projection Fig. 212. Here the two reast planes or pedicus are district terms, followed the property of the property of the general distributions of the carnel class, though distributionally

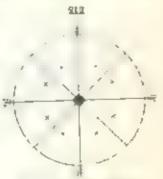
ty their theorem it seriesture, further, he just a later to larger louble puriations and each form is represented by muchal of Ligs 192–196, 205 of Fig. 44 p. 23. There are heave as the represented forms, corresponding to be appear and lower to west of the first and second order pyramics and the diletragonal pyramics.

### TRIPYRAMIDAL CLASS (8). SCHEELITE TYPE

(Tetragonal Dipyramidal Pyramidal Hemiliedral, in Tetragonal Equatorial Class)

103. Typical Forms and Symmetry Vert.

Az. 4, hor. P; C. and forms here included the construction only that is he



Symmetry of Leminorphia Chart

taker one plane I swill stry only that I he he contains a swill operate axes, and one axis of todough half swillnessly I to a recall rays along the axis moral to at. The its period i ma are the totage and prisin has a and pyramid that of the third acceptahows in Figs. 214, 215.

The stereographic projects at Fig. 213 extracts the symmetry of the class and the distribution of the faces of the general torns that the expansion has

1125 17

Symmetry of Triporamidal Class

as well as the Eg tree. In researchy to having with those of the return class, it is seen that this class caffers from it in the despect of the vertex primes of synanctry and the ladracound axes from the resound axes.

104 Prism and Pyramid of the Third Order.

The type of raised to class he show states, are a square present of a separe perment which are distinguished respectively from the square primary at 100 and minutes, own to figs 198 and 199, the from the square pyramids that and what of fags, 192 and 196 by the name third order."

The third order prises and paramed may be considered as derived from the distinguisforms of the manal was by same orly one half the faces of the latter and the omession of

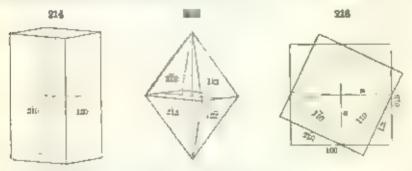
the remaining faces. There are therefore two complementary forms in each case, lesignated left and right while the gether in late all the faces of the discregand prism. Fig. 191, and discressional pyrams to buy 2050 of the normal class.

The makes of the faces of the two complementary prisms, as (21), are

Left 210, 120, 210, 120. Right, 120 210, 120, 210. The indices of the faces of the corresponding pyramids, as (212), are

Left above 212, 122, 242, 132, below 212, 125, 212, 127, Right above 122, 212, 122, 212, below 122, 212, 123, 212.

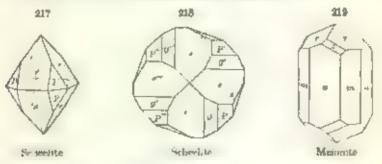
Fig. 216 gives a transverse section of the prisons of 100, and m(110), also the prison of the third order (120). Figs. 214, 215 show the right prison (120) and pyrhond (122) of the third order.



Third Onter Priem

Third Order Pyramid

105. Other Forms. — The other forms of this class that is, the base could the other course prisms at 100 and mol 100 also the square pyramods half and the are go metrically also be corresponding forms of the near all class a ready described. The class shows therefore three types of square pyramids and hence is called the trapyramidal class.



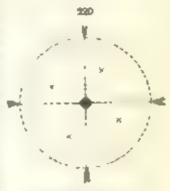
106. To this class belongs the important species orbients also the isome riphous species sto are and powell a interset or that they are rather to be chassed with an femule point. Fig. 217 shows a typical crystal of schedule, and Fig. 218 a hand section of an armonic, these diastrate well the characteristics of the class. Here the forms are s(101), p. 111, and the third roles pyramics g(212), s. 131. Fig. 219 represents a meiobile crystal with roll11, and the third order pyramid. \$11). See also Figs. 221, 222, in which the third order pressue shows

The forms of this class are sometimes leserified (see Art. 27) as showing parameted heminedrium.

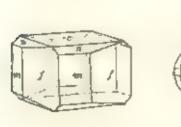
# 4 PYRAMIDAL-HEMIMORPHIC CLASS (9) WULFENITE TYPE

Tetrogonal Pyramudal, Hemihedral Hemimorphic, or Tetrogonal Polic Class)

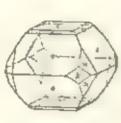
107. Symmetry. Vert Ax.-4. The fourth class of the tetragonal system is closely related to the class just described. It has the same vertical axis of tetragonal symmetry, but there is no harrice tal plane of symmetry. The forms are, therefore, her amorphic in the distribution of the faces (cf Fig 220). The species wulfemite of the Schoente Group among unpend species probably beiongs here, asthough the crystals do not always show the difference beeven the pyramidal faces, above and below. which would characterize distinct complementary forms. Figs. 221, 222, could, therefore serve as illustrations of the preceding class, but in Fig. 223 a characteristic distinction is exhibited. In these figures the forms are to 102), c(101),  $n_1111$ ), also f(210), k(210), z(432), z(311).

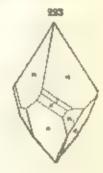


Symmetry of Pyramidal-Hammarphic Class



997





Wulfemte

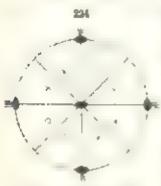
# 5. SPHENOIDAL CLASS (10) CHALCOPYRITE TYPE

(Tetragonal Sphenoidal, Sphenoidal Hemihedrat, Didigonal Scalenohedral, or Ditetragonal Alternating Class)

108. Typical Forms and Symmetry. 3 zl. Az.-2, 2 vert. diag. P. — The typical forms of this class are the spherical (Fig. 225) and the tetragonal academonderon (Fig. 226). They and all the combinations of this class show the following symmetry. The three crystallographic axes are axes of binary symmetry and there are two vertical diagrams manus of symmetry.

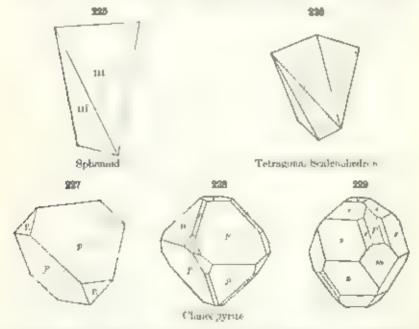
This symmetry is exhibited in the stereographic projection (Fig. 224), which shows also the distribution of the faces of the general form (hit). It is seen here that the faces are present in the alternate octants only, and it will be remembered that this same statement was made of the tetrahedral cases under the sometric system. There is hence a close among between

these two classes. The symmetry of this class should be carefully compared with that of the first and third classes of this system already described



Symmetry of Sparmoids. Cine

109. Sphenoid. The sphenoid, shown in Fig. 225 is a four-freed solid, resembling a tetrar edron Last each face is an iscences and an computeral triangle. It may be considered as derived from the first order pyramid of the perman class by the development of only the internate faces of a latter. There are therefor poss te two complementary forms known no he poer to and negacine aphenoids. general symbol of the positive unit sphenoul is (111), and its bees have the indices 111, 111, Til III while the negative sphenoid Las the sym.bc. (111 When the complementary forms occur together, if equally developed the result ing so id though baying two unake sets of faces, cannot be hetagaished geometrically from the first order pyramid (111)



In the species chalcopyrite, which belongs to this class, the deviation in angle and in axial ratio from the isometric system is very similar, and hence the unit sphenoid cannot by the cyc be destignished from a tetrahesism (compare Fig. 227 with Fig. 162, p. 84. For this species c = 0.285, asstead of 1, as in the isometric system, and the normal sphenoidal angle is 108° 40, instead of 100° 28′, the angle of the terrahedron. Hence a crystal of cana-

repyrite with both the positive and negative aphenoids equally developed causely resembles a regular actanedron

In Fig. 225 the second order pyramids c(101) and z(201) and base c(001)

110. Tetragonal Scalenohedron. The sphenoidal symmetry yields an iter distinct type of form, it it shows in Fig. 226. It is bounded by each similar scalene triangles, and hence is called a tetragonal scalenohedron; the general symbol is that. It may be considered as derived from the first policy partial of the pormal class by taking the internate pairs of the fatter form. The faces of the complementary positive and negative from therefore embrace al. It faces of ht differential pyramid. Thus I true appears in combination in charcopyrite, but is not observed independently. In Fig. 229 the form good in the positive tetragonal scalenohedron.

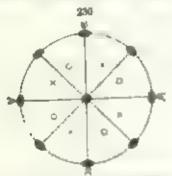
111 Other Forms. — The other forms of the class, namely, the first and second order prisms the diletingonic prism and the first and second order pyramids (hild and child), are geometrically take those of the normal class. It is lower symmetry in the molecular structure is only revealed by special

investigation, as by etching.

# 6. TRAPEZOHEDRAL (LASS (11) NICKEL SULPHATE TYPE

(Tetragonal Trapezohedral, Trapezohedral Hemshedral or Tetragonal Holoarial Class)

112. Vert Ax.-4; 4 hor. Ax.-2. The temperahedral class is analogous to the plagealedral class of the sometric system. It is cannected by the absence of any plane or center of symmetry, the vertical axis, however, is



Symmetry of Trapezobedral Class



Tetragonal Trapezohedron

of timers symmetry—It is symmetry and perpendicular to this there are for a size of timers symmetre—It is symmetry and the disorder or of the larges of the general form (blee are shown at the storeograph expapers on, Fig. 230, and Fig. 231 gives the resulting suitd, a telesponal traperoheteon—It may be crived from the metetrized all pyramid of the normal class by the extension of the all erange trees of that form—There are two conjubrantary forms called right- and left-handled which embrace all the faces of the diterragional pyramid.

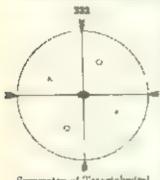
of the normal class. These two forms are mantisomorphous, and the salts belonging to this case show circular polarization of light

Nickes sulphate and a few other artificial salts belong in this class.

#### 7 TETARTOHEDRAL CLASS (12)

(Tetragonal Durphenoidal, Sphenoidal Tetartohedral, or Tetragonal Alternating Class)

113 Symmetry Vert. Ax -2. The seventh and met possible class under this system has no plane or center of symmetry, but the vertical axis



Symmetry of Tetarioberital

is an axis of binary symmetry. The symmetry and the distribution of the faces of the general form (likt) are shown in the stereographic projectem thig 232, and the resulting sola is known as a spheroud of the third order. It can be derived from the litetraconal pyramid of the pormal class by taking only one quarter of the faces of that form There are therefore four complete entary forms which are respectively distributed as right of and and left + and four together embrace all the exteen faces of the di etragonal pyramid. The other characteristic forms of this class are the prism of the third order (Akt), the positive and negative sphen-ds of the first order 111), and also thuse of the second order (101). It is said that an artificial

compound, 20 st) Al<sub>2</sub>O<sub>2</sub>S<sub>1</sub>O<sub>2</sub>, crystaluses in this class.

#### MATERIAL RELATIONS OF THE TETRACONAL BUSTON

114. Chance of Axes. It appears from the discussion of the eventuality of the seven casses of this system that with all of them the post on of the vertice axis is fixed. In times, 1, 2, he was a where there are two notes of vertical phases of symmetric either set may be under the axis passes the attention that the Lagrant platter. The chance there are two possible positions of the bottomath when is great particularly 1, he amount of the covering crystem and the measurement of the given species to obtain it makes one. With a space whose regards characters have been described it is a measurement to focus the original described.

116. Determination of the Arial Ratio, six. The following relations serve to connect the Arial ratio, that is, the sength of the vertical axis c, when a = 1, with the fundamental

engles (001 A 101) and (001 A 111)

$$tan (00) \land 10 \rightarrow c$$
,  $tan (00) \land 111 \times 1\sqrt{2} \rightarrow c$ 

For fares in the same rectangular was the tangent principle applies. The most important cases are:

$$\frac{\tan (001 \land h00)}{\tan (001 \land 001)} = \frac{h}{l};$$

$$\frac{\tan (001 \land 0kl)}{\tan (001 \land 0kl)} = \frac{k}{l};$$

$$\frac{\tan (001 \land kkl)}{\tan (001 \land kkl)} = \frac{h}{l};$$

For the prints

$$\tan (010 \land hk0) = \frac{h}{k}$$
, or  $\tan (100 \land hk0) = \frac{k}{k}$ 

116. Other Calculations. - It will be noted that in the mercographic projection. Fig. 210. all those spherical changles are right-rights which are formed by great circles than error which meet the prisonant some-circle 100, 010, 100, 010. Again an those formed by great circles from between 100 and 1 to or 010 and 010 and comming respectively the courcles 100, 00, 100, or 010 00 t, 010. Also, ad high formed to great circles and true of the circles 100, 00, 100, or 010 00 t, 010. Also, ad high formed to great circles and revenue. 110 and 110 an

These spherical trunges may besee to medily used to calculate any angles desired for the green case. For example, the software case is readily used to capture any angles desired for the copie, the angles between the pole of any face as \$44 sax 731 and the quantum 100 lb. 1.0 to 1 lb. The terminal angles 7 and 9. Fig. 26% of the direct against pyramid. 1.2 A 213 with 313, etc., and 212 A 22 or 313 A 123 etc. and any be obtained in the same with The sonal relations give the symbots of the pages on the sones 001 and 001, 1.0 for the green case. For example, the innectable 110 at 133. He most 110, 00), 110 at the pole 253 and the case made angle 3.3 A 223 is half the angle 313 A 333. If a large bumber of similar angles are to be calculated, it is mare convenient to use a formula, as that given below

It is nometimes convenient to have the normal interfaces, single-117 Formulas.

expensed directly in terms of the axis c and the actions h. k. and t. Thus

1 The distances of the pole of any face  $P_i h h_i$  from the pinacoids  $a_i(00) = P L_i$  b(010, -P h, c(001, -P c)) are given by the following equations

$$000^{2} \text{ Fo} = \frac{h^{2}c^{2}}{h^{2}c^{4} + h^{2}c^{2} + h}, \quad \cos^{2} Pb = \frac{h^{2}c^{4}}{h^{2}c^{4} + h^{2}c^{2} + h}, \quad \cos^{2} Pc = \frac{p}{h^{2}c^{4} + h^{2}c^{2} + h^{2}}.$$

These may also be expressed in the form

tan<sup>3</sup> Pa = 
$$\frac{k^3c^2 + l^3}{k^2c^2}$$
, tan<sup>3</sup> Pb =  $\frac{k^2c^2 + l^3}{k^2c^2}$ , tan<sup>3</sup> Pc =  $\frac{k^3c^4 + k^3c^4}{l^3}$ 

(2) For the distance between the poles of any two faces (hit), (par), we have in general

$$eqn PQ = \frac{hpc^4 + bp^4 + b^4}{\sqrt{(h^2 + b^2)c^4 + b^2 + p^4 + p^4)c^4 + p^4}}$$

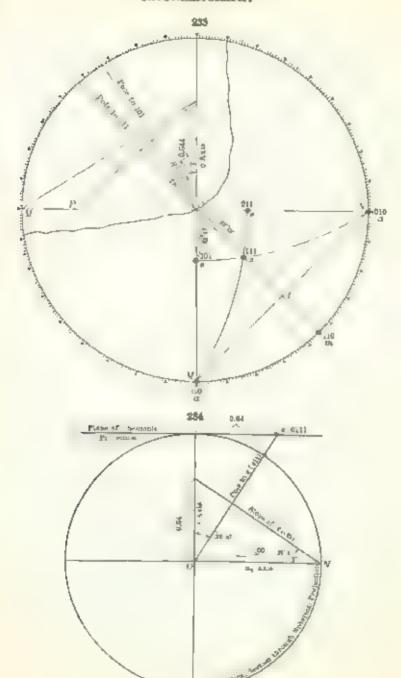
The above equations take a simpler form for special cases often cocurring, for example, for ald and the angle of the edge ; of Fig 206

118. Prismatic Angles. — The angles for the commonly occurring distringuish prisms

are as follows:

	Angle on	Angle on mol10)		4 1000	Angle on m(110)
410 310 210	o 100) 14° 21' 18 26 26 34	30" 571" 26 34 18 20	530 320 430	30° 57‡ 33° 41‡ 36° 52‡	14" 21 11 18 8 7

119. To determine, by plotting, the exial ratio, a c, of a teleagonal mineral from the storeographic projection of its crystal forms. As an these ration example ( has been similar and the angles between the faces in the crystal of rathe represented in Fig. 198, has been measured and from these measurements the pulse of the large in one octant becaused on the stereographic projection, see Fig. 33. In determining the actual ratio of a le carronal cryotal or what is the same thing, the reach of two coxis, since the resign of the a axive are always taken as equal to 1 to a necessary to assume the indicate of some pyromethy form. It is customary to take a pyron- which is prominent again the crystals of the numeral and assume that if is the fundamental or unit (visitor of other the first or secretar order and has as its symbol other 111 or 101. In the example chains both a fire, order and a second order pyramu i are present and from their cond resultant it is evi-Cant that if the symbol assumed to the first over form be 111) that of the second order form must be (101) In under to determine the relative length of the c sais in respect to the length of the a axis for run is therefore, it is only necessary to plot the interpet of either of these forms upon the axis. In the case of the second order syrams it is only either of these forms upon the axis. In the case of the second order syrams it is only reseasely to construct a right angle triangle over upper left-hand quadrant of Fig. 233. In which the horizontal side dim equal the length of the diams. In worthese side shall represent the class and the importance shall show the proper angle of about the face. The angle between the center of the projection and the proper angle with the line representing the storeographic protester and a line drawn making that angle with the line representing the



c axis. The hypothermise of the rangle must then be at right angles to this pole. Its interrept from the certical size of the triangle, when expresses in relation to the distance of M which was shown as representing the six of the quality with therefore give the length

I that area to receive the is fend to be 1 144

The same as we as sound when he pass on of the pyramid of the first color fill, is near. In the case we have Monthly is here been as right angles to the range that the first through the pair of 1.1. The transple to we after do this case has the detance of P as the length of its horizontal ender the hypotherized draw tent to at right argues to the representing the pair to the 1.1. The intercept in the case is the same as in the first

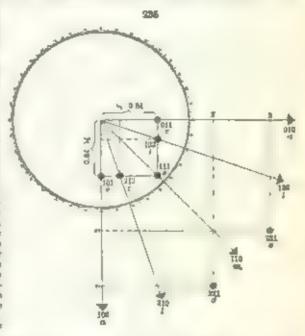
120. To determine, by plotting the indices of any face hist of a tetragonal form from the position of its pote on the stereographic projection. The solution of this purchase is the true given in a similar case in our face connected in stem, see p. We except that the never pt of the face in he retrieval axis in all the reserved to the esta district, and length of that are and act to the length of the name of the reserved in the reverse of the

one used in the proofer was used preetly share

131 To determine, by plotting, the axial ratio, a c, of a fetragonal mineral from the gnomonic projection of its crystal forms. As an issurative example consider the crystal for, le rig 198, the same to the faces of which are shown a set on gnomonic projection to leg 236. The presents of the first and second order present are taken as the most forms with the symbols, with and of the first and second order present are taken as the two horses of axes, and a, and to the answer from the center O to the current respective to the tadaments, carrie is equal to make on these axes. The intercepts on O-M and O-N

must be the pease of a 10) or my perpendicular arises from the poles of a 111 give the nut ength of the vertical axis, a. In this case the distance, when expressed materials of the assumed league of the barrier than axis with a terragonal system is equal to 0.64.

That the above relation et there is by ago from a cona term up of Fig 24 The represents a vertica securit through the spherical and guerne or an per son me admg the b regional axis, or The slope of the face e(01) to plotters with its intercepts on the acatal concer and he prostone of the pole in took the spherral and guomonic projects he is shown it a need through the two sines ar trangles in the figure a title untaine from he cer er to the sale e 0.1 m the garmenie projection ment be the store as he prepriet if the from e upon the yes all axion. And are is a on a form thus



must represent my your 122. To determine, by protting, the indices of any face of a tetragonal form from the position of its pole on the gnottonic projection. It is seen that in the case a regard in he agreement which we have a many perpendicular for a he yellow, just not be now representing to two he resultance may perpend the others have indicated on the many of the many to the many have all the many many to the case which is then agreed that it he case represents of the many of the many of the case which is the decay represents to the projection of the arrest of of

tength of the vertical axis add a 1 so the third ingure and if recovery char of fractions and the resident access are the resident. This is the resident in 1 gifts which is the other photon of the state show in he rather than they had been formed by the state the state to the first the state the state the state to the first the state that the state that the state the state the state the state the state the state that the state t

#### III HEXAGONAL SYSTEM

129. The hexagonal evatem includes all the forms which are referred to four axes, three equal horizontal axes in a common plane intersecting at

angles of 60° and a fourth, vertical star, at right angles to them

Two sections are here moleded, each embracing a number of distinct classes related among themselves. They are called the Heragonal Division and the Tragonal or Rhemboketrali Division. The symmetry of the former, about the ver ital axis, belongs to the homogenal type, that of the latter to the trigonal type.

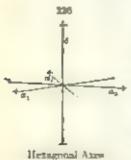
M of 1852 referred all the forms of the horagonal evates to three equal axes parallel to the curse of the first enter those behaviors and time is a second at equal angles, and got. This met is a refer explainted to Ar. 170 had the less a large first got being not the relaterable parallel to the parallel parallel parallel to a disciplinary which he horses heregonal and terragonal great both increaserated to a disciplinary at a parallel paral

124. Symmetry Classes. There are seven possible classes in the Hexagonal Division. Of these the normal class is in its the most important, and two others are also of importance among crystal ized minerals.

In the Imgona lives in there are five classes of these the riou beheard was or that of the falcite type, is by far the most common, and three others are also of importance.

136. Axes and Symbols. The position of the four axes taken is shown in hig 238. The three horison at an axes are called a same they are equal and introduced and according to hongenide and according to honger or shorter than the horizontal axes. The length of the vertical axes actives and that of the horizontal axes which in turn is aways taken as any further when it is desirable to distinguish between the horizontal axes which is desirable to distinguish between the horizontal axes which is desirable to distinguish between the horizontal axes they may be designated at the first potal axes they may be designated at the first potal axes they may be designated at the first potal axes they may be designated at the first potal axes they may be designated at the first potal axes they may be designated at the first potal axes they may be designated at the first potal axes they may be designated at the first potal axes are the first potal axes and the first potal axes are the first potal a

properly orientated one of the horizontal axes  $\alpha_{ij}$  is para isl to the observer and the other two make angles of 30 either aide of the one perpendicular to him. The axis to the left is taken as  $a_{ij}$  the one to the right as  $a_{ij}$ . The



positive and negative ends of the axes are shown in Fig. 236. The general position of any paper may be expressed in a manner analogous to that applicable in the other systems, viz.

The corresponding tadices for a given plane are then h, k, t, these always refer to the axes named in the above scheme. Since it is found convenient to consider the axes  $a_k$  as negative in front and positive behind, the general symbol becomes hkil. Further, as following from the argumer relation of the three horizontal axes, it can be readily shown to be aways true that the algebraic sum of the indices h, k, t, is equal to zero:

$$h + k + i = 0$$

#### A. Hexagonal Division

#### 1 NORMAL CLASS (13) BERYL TYPE

(Diheragonal Dipyromidal, Holohedral, or Diheragonal Equatorial Class)

126. Symmetry. Vert Ar.-6; 6 hor Ar.-2, 6 vert P., hor P., C.— Crystale belonging to the normal case of the Heragonal Division have one principal axis of hexagonal, or sixfold symmetry which coincides with the vertical crystallographic axis, also six herizontal axes of binary symmetry;

three of these coincide with the borizontal crystall-graphic axis, the others beset the angles between them. There is one principal plane of symmetry which is the plane of the borizontal crystallographic axis and six vertical planes of symmetry which meet in the vertical crystallographic axis. Three of these vertical planes include the turizontal crystallographic axes and the other three bisect the angles between the first set.

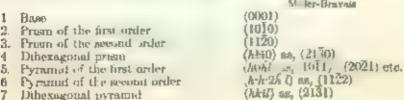
The symmetry of this class is exhibited in the accompanying stereographic projection, Fig. 237, and by the following crystal figures.

In the above h > k, and h + k =

The analogy between this case and the Symmetry of Normal Chamber and the settingous system is obvious at case and will be better appropriated as greater familiarity is gained with

at once and will be better appropriated as greater familiarity is gained with the individual forms and their con bunketes.

127. Forms. Inc possible forms in this class are as follows:



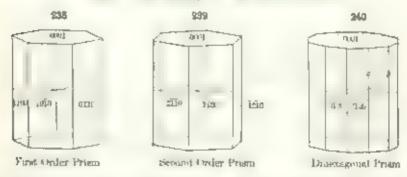
128. Base. — The base, or basel perioded, includes the two faces, 0001 and 001, partial to the plane of the harrzonial axes. It is uniformly designate, by the otter c, see Fig. 238 et seq.

129. Prism of the First Order - There are three types of prisms or

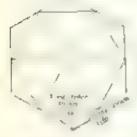
forms in which the faces are parallel to the serrical exis-

The prism of the first order, Fig. 238 melocas six three each one of water is parallel to the vertical axis and mesos two deprical horizontal axes at equal distances, while it is parallel to the three norizontal axis. It has her ce the general symbol of 0 to and is undermy designates, it is latter in, the indices of as six faces taken in order set lags 235 and 247, 248, and

1910, 0110, 1100, 1010, 0116, 1100.



130. Prism of the Second Order. The prism of the second order Fig. 239, has sex these each one of all on a parallel to the vertical reasons meets. On the horizonth exists with remove axes at the unit distance the intermedance axis at one half this distance or which is the same thing a meets the last named axis at the not distance, the others at double the distance. The general symbol is (1120) as let is undertaky designated by the latter of the axis faces see Figs. 340 and 247, 248) in order are:



#### 1120, 1210, 2410, T120, 1210, 21To

The first and seem I order prises are not to be distinguished geometric dy from each that since each is a region functional prism with normal interfacial angles if 60°. If my are related to each other in the same way as the two prises in 1.0 — 1.0 10°. If the tetrage is explain.

The relation is position by ween the first order prism and pyrancis in the one I and not do sent I be order prism. If yearn its on the order will be

an erstood be for from Fig 241, represen ag a cross section of the two

50 Pd. rising a the ed by twenter faces out the face of the parameter the

yeri cal axis, and also meets two adjacent horizontal axes at unequal distances, the ratio of which always has be ween 1 \*, and 1 2 This prism has two unlaw edges, lettered x and y, as shown in Fig. 240. The general symbol is blat, and the a lace of the faces of a given form, as (2.30), are.

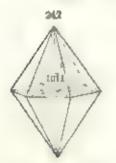
2150 1230, 1320, 2310 3210, 3120, 2130, 1230, 1320, 2340, 3210, 3130

132. Pyramids of the First Order - Corresponding to the three types

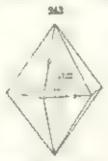
of prisons just ment cood, then are three types if paramids

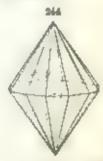
A pyram d of the pred order Fig. 242 is a discole six-s ded pyramid (or dipyrman a bour dot by twelve similar (mangular faces six above and six below which have the same position relative to the foregonial axes as the faces of the first from prism, while they also in crises the vertical axis above and serow. The general symbol is hence Jobby. The fixes of a given form. ns (IDII), are:

> Above 1011, 0111, 1101, 1011, 0111, 1101 Below 10.1, 0111, 1101, 1011, 0111, 1101









Dilmingma, Pyramid

On a given species there may be a number of pyramids of the first order, differeng in the race of the intercepts on the horizontal to the vertical axis. and thus forming a zone between the base (0001 and the faces of the unit prism (1010 Their symbols passing from the base '0001) to the and presen (1910), would be, for example, 1014, 1012, 2023, 1011 3032 2021, e c In Fig 246 he faces p and a are first order pyramids and they have the symbols respectively (1011) and 2021, here c=0.4989. As shown in these cases the frees of the first order pyran its replace the edges of the first order prism. On the other hand, they replace the solul angles of the secon, order prism, act 120

133. Pyramids of the Second Order. The pyramid of the second order (Fig. 243 is a double six-sided pyramid including the twelve similar faces which have the same position relative to the horizontal axes is the faces of the second order prism, and which also intersect the vertical axis. They have the general symbol (h h 2h - l). The malices of the faces of the form

(£122) nre

12.2, 2112, 1122, 1212, 2112

This form (1172) is to be considered as the unit second order pyramid, rather than the form (1171). This is seen when the parameters are noted, via., 2a., 2a., 1a., 1c. Its indices are also to be of tained by adding those of the faces of the first order unit pyramid between which is her, as (1011. + (0111) = (1172).

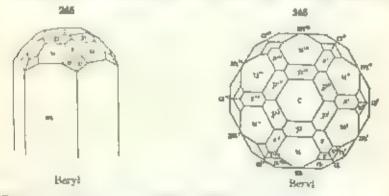
The faces of the second order pyramid replace the edges between the faces of the second order prism and the base. Further, they replace the solid angles of the first order prism  $m_i \cap i n_i$ . There may be on a single crystal a number of second order pyramids forming a same between the base of 0001 and the faces of the second order prism a(1120) as, naming them in order a(1121). The first a(1121) is the second order pyramid a(1121).

134. Diberagonal Pyramid. — The inheragonal pyramic. Fig 244 is a double twelve-a ion pyramid having the twenty-four summer faces embraced under the genera symbol (han. It is bounded by twenty-four similar faces each tree ing the vertical axis, and also thereing two adjacent horizontal axes at unequal distances, the ratio of which always lies between 1 1 and 1 2. Thus the form (2131) includes the following twelve faces in the upper half of the crystal.

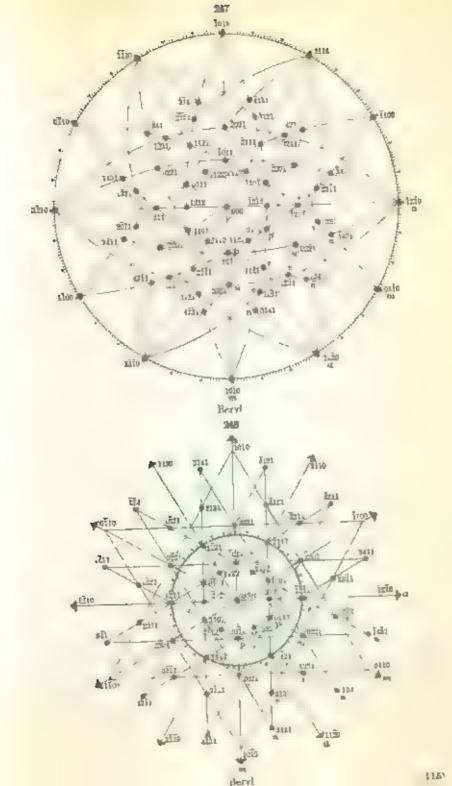
2131, 1231, 1331, 2311 3211, 3121, 231, 1231, 1321, 2311, 3211, 3121

And similarly below with l (here 1) negative, 2131 etc. The diheragonal pyramid is often called a berydoid because a common form with the species beryl. The dihexagonal pyramid etc.31, is shown on Figs. 42, 243.

135. Combinations. Fig 245 of bervi shows a combination of the base c(0001, and prism m(1010) with the first order pyramids p.1011) and



at 2021). The second order pyramid of 11211 and the differenced pyramid is 2131. The basis, projection of a similar crystal shown in Fig. 246 is very instructive as exhabiting the symmetry of the normal nexagonal class. This is also true of the storographic and gnomenic projections in Figs. 247 and 248 of a like crystal with the added form o(1122).



#### 2. HEMIMORPHIC CLASS (14) ZINCITE TYPE

(Diheragonal Pyramidal Holokedral Hemimorphic, or Diheragonal Polar Class)

136. Symmetry Vert. Ar.-6; 6 vert. P. — This class differs from the normal class only in having no horizontal plane of principal symmetry and



Synanty of Languages Cha-

no horizontal plane of principal symmetry and no horizontal axes of binary symmetry. It has, however, the same six vertical places of symmetry incepting at angles of 30 in the vertical crystall greighter (x,s,w) at the six axis of hexagonal symmetry. There is no certer of symmetry. The symmetry and the stereographer projection, Fig. 249.

137 Forms. The forms belonging to this chase the two based planes of perions 1000, and 1011, here restrict forms, the president topper) and negative fower pyramids of each of the three types, also be three preside, which had do not caffer geometrically from the preside of the port. class. An example of the case

to found in ricette hig 44, p 23 Latyrite, greenockite and wurszate are

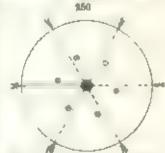
#### 8 TRIPYRAMIDAL CLASS (15) APATTE TYPE

(Recagonal Dipgramolal, Paramodal Hemshedral or Hexagonal Equatorial Class)

138 Typical Forms and Symmetry Vert. Ax.-6, her P : C. This class is important because it well des the common spic es of the Apartic Group, apartic pyresmorphite in aictite, variadante. The typical form is

the being tal prism (hki0) and the heingened printed test, each lesignated as of the third order. These forms which are shown in Figs. 251 and 252 may be considered as derived from the corresponding different forms of the normal class by the omesion of one had of the faces of the latter. They and the other forms of the class bave only one plane of symmetry the plane of the lacezontal axes, and also one axis of hexagonal symmetry, the vertical axis.

The symmetry is cubilited in the stereographic project in thig 250). It is seen here, as it, the figures of crystals given, that like the triogrammidal lass under the to regions symmetry.



Symmetry of Trepyramatal Class

tre frees of the general form this present are half of the possible planes becoming to each section, and further that these above and selow fad in the same vertical robe.

139. Prism and Pyramid of the Third Order. The prism of the third order (Fig. 251 has an ake faces embraced under the general symbol (hkt0).

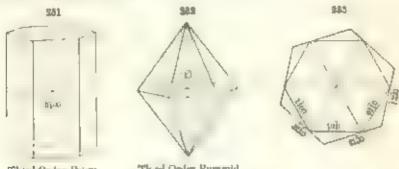
and the form is a regular hexagonal prism with angles of 60° met to be disto gain ed geometricals of alone from the other hexagor a prisans, of 1 gs 205 249, p. 112 The aix faces of the right-handen form 2130 have the Habers

2130 1320, 3210 2130 1320, 3210

The faces of the complementary left-handed form have the indices

1230, 2316, 3120, D30, 2310 3F20.

As alrea is stated these two forms together embrace as, the faces of tandihexagonal presm (Fig. 240).



Third Order Prism

That Order Pyramid

The pyramid is also a regular faulth because all pyramid if the tard erder, and in the relations to the over a brangered pyranicial of the class characters. 242 243 d s and gone to the square are ged if he therd order that a th It the correspon ing class of the tetragonal system see Art 106, The faces of the right has led form 21st, are

Above 2131, 1321 3211, 2331, 1321, 3211, Below 2131, 1321 32,1, 2131, 1321, 3211,

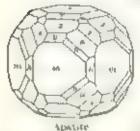
There is also a complementary of the aided from which with this embraces all the frees of the divergental prograd. The cross section of Fig. 253 divina in outlier tre position of the fire order priority at a also that of the right has bee presh of the tord or fer

I se prosu and pyrmuid just described so us t often appear on crysta a as predering forms though this is a metanes it a case, but comme an those

fores are present intollying constitutionness, forms

140. Other Forms. The remaining forms of the class are geometrically like has of the normal class, we the have DOLL the first open prisin (1640) the second order priso (1120) the first order pyramids (heal) and the second creier paramide (h h 2h l. That their morecular structure however, corresponds to the symmetry of this class is read ty proved for example, by etering. In the way it was shown that pyromorphite and mimelite belonged in the same group with apothe. Baumhauer) though crest is with the typical forms had not been observed. This class is given ets name of Trappromulal because its forms include three distinct types of DYTAMICS.

141. A typical crystal of spatite is given in Fig. 254. It shows the third order prism h(2150), and the third order pyramids, μ(2151), h(1111), as of the first order pyramids τ(1112), π(1011), μ 2021), the second order pyramids τ(1122), π(1121), finally the prism, m (010), and the base τ(000).

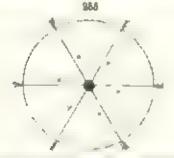


#### PYRAMIDAL HEMIMORPHIC CLASS (16) NEPHELITE TYPE

Hexagonal Pyramidal, Pyramidal Hemihedral Hemimorphic, or Hexagonal Potar Class)

142. Symmetry. Vert. Az. 6. — A fourth class under the bexagonal division, the pyramida neummonic place is like that just described, except that

the forms are hemamorphic. The single horizontal place of symmetry is absent but the vertical axis is still, an axis of hemagonal symmetry. This syntheory is shown in the stereographic projection of Fig. 255. The typical



Symmetry of Pyraguida, Hememorphic Class



958

Nepheata

form whals he also the upper half of Fig. 252 of the pyramutal the third order. The species in pincipal is shown by the character of the clothing figures (Fig. 256, Great ofter Boundament of books here.

#### 5 TRAFLZOHEDRAL CLASS 17, \$ QUARTZ TYPE

(Resagonal Trapezoledral, Trapezoledral Hemiliatral, or Hexagonal Holoaxial Class)

143 Symmetry Vert Ax -8. 6 hor Ax -2. The temperatural elements no plane of symmetry, but the vertical exists are axis of hex gorrid symmetry, and there are, for her six horizont a axes of hexigonal symmetry, and there are, for her six horizont a axes of hexigonal trapes of the typical form while is shown in the stereographic projection (Fig. 2. 1). The typical forms may be derived from the discussional premised by the massion of the alternate forces of the latter. There are two possible types known as the right and left hexagonal trapexobedrous (see hig. 25% which are ensistency) hours, and the few crystallized saits fading in this class show

carether polarization. A monahess in of quartz anown as sequents a also described as belonging here. The indices of the right form (2), are as follows.

Above 2131, [321 3211, [131, 4321, 3211] Below 1241, 201, 3121 [231, 2311, 3321]



Symmetry of Trapezobedral Class



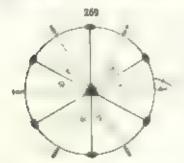
Decagonal Trapezobedran

### 6 TRIGONAL CLASS IS BUNIFOUT TYPE?

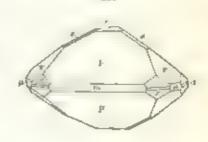
(Intergonal Depyramidal Terg as, it methodeal, Trigonolype, or Ditrigonal Equational Class)

144. Typical Forms and Symmetry Vert Ax -3; 3 hor. Ax -2; 3 vert.

P, hor P = The class to a section the vertical trace of rights, symmetry, three herizontal axes of binary symmetry which are angenia to the restallograph waxes. There are four partial symmetry and he are utal, and three



Symmetry of Trigonal Class



Benton e Paluche

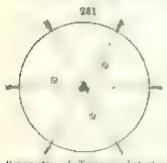
vertical diagonal places in especting at angles of 60° in the vertical axis. The symmetry and the distribution of the fires of the positive integrand pyramid are shown in Fig. 250. The characteristic forms are as follows. Trigonal prism consisting of three faces countristing one half the faces of the

<sup>\*</sup>Supropted Classes Sur | 10 were as ground under he change bedeat Discount because of their vertices was direct or or their. The writes who are observed trader to the hexagonal classes and are more properly placed here.

becagenal prism of the first order. They are of two types called positive (101) and negative 01x0. I regard pyras at adouble time-faced pyramid. commanding of an faces corresponding to one half the faces of the lexignment pyraphyd of the tire of the later than the later of the tire that in vertical zones with each other. There are two spes, called post we full, and tage on (0) is Intrigued by tank cornects of any vertical fairs arranged it force son as sets of two faces and has no therefore the distribute is got of different ename or I may be derived from to I have get all prints by taking it in this pries of fees things hat pyr on tempest. I twill form ex they, and ax slow It use the prism may be derived from he dit exagonal form by taking aborn to pairs of faces of the latter. The faces of the upper and lewer his ves fall in vertical zinces. The ally represent their flame to see an way is the tare it more benitoite, a crysta. If which is represented in Fig. 200, This exvists shows the trights prists w 10,0 and and antito, the become cross of the second rear oil (2), the tragonal pyramos printl) and r (111), e.01 2 and the hexagona (yrams) of its second elect 5 Sept 1

#### 7 TRIGONAL RETARTOREDRAL OF DISHAFRORTHO PHOSPILATE TYPE

Tragonal Departmental of To genul Equatorial Chan



Smalletry of Traping Colorle-

145. Vert. Ax.-3, her P This cases has one plane of ayu metry that of the borgertal ages and the axo of trigonal avii it it its the vertical six s . In me is no color symmetry. I sub-meteristic female in the three cities of Ingeles, pricing and the tree corresponding types of the tal parament, of the 201 the class has not known representation, mong ninerale

#### B. Rhombobedral Division

Five classes at metadec a the Rhembobeard to a se of the H x-good System of when the laterable budge to perofit in Calcite type is oy far the most orige rians.

#### RROMBORFORAL CLASS QUALCULE TYPE

(Diregonal Scalenohedral Heragonal Scalenohedral, Rhandinhedral Hemitodeal or Tribezoaman Surrent na Class.

146. Typical Forms and Symmetry Vert Ar-3, 3 hor at At -2, 3 vert, diag P , C. The typical forms of the roombohedral disse are the rhopshohedron (Fig. 263) and the seal is redron, Fig. 278. These terms we the projections, have 200 and 288, all istrate the available of affect creater of the class. There are there planes at symmetry only these are discretell in the horizontal ervetallographs are and intersect at any most fift in our vertical crystallographic axis. This axis is with these forms an axis of trigonal symptetry, there are, further three horsents, ages partial to the crysta-

By comparing high 288 with high 247 philips in with he seem has all the forces. that he seed as are present. This group is herer and goes to the other beston chose I am escale the system, and the spacement base of the tetragon d avalam.

147 Rhombohedran. Commetrically Jeserabed the Mountahedran is year bour had ay a the faces, and a thomb. It am styl so lateral odges

for my a carry has about a crystal and sax ke bern mad edges three bear of three in nother the leading with the virties, an a going the two ribedre soul sigles, in I the horizonto ax s pan the and e points of the opposite mden, as shown in Fig. 264.

The general symbol of the thou behedrer a (hth , are the enecessive faces of the unit local

(1011) have the indicent

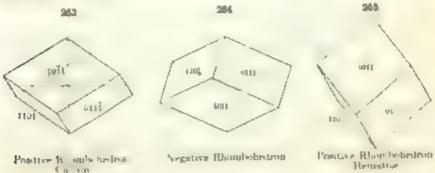
Above 1011, [101, plit, below, 011], Total, 1fol.

The geometrical as are of the rhomboliedeon varies where y as he argles change and satisfaquently the relative veg cof the vertical axis c

282

Seminetry of Rhoughshedral ( sum

As the viette lavis done respressed in terms of the borgonty avenue to ester, the rait has released manual to be and to be obtone a plaste and and an it increases they begin to it is and in to make. A cobe placed with an octalleded axis ve tracis class say the arriving ense between the obtainer of Most forms where the peface argh is 90' In log 203 of carette the merry themboses at come a 74° 5 at c = 0% I wo lo for the 265 of box dute this armie is 51 and c 1 356 Further Figs 255 270 slow in her them schedibles of early percely 601121 schools, f 0221, Metcht and public by I have the very of axes are the the ratio ( ) 1, 2, 4, 16, to the of the fundamental clear ge, rhombohodron of Fig. 263 whose right detertumes the value of c.



148. Positive and Negative Rhambahedrans. - Thorogy positive thombsebedron there was be an inverse and comprehentary form, I lentical geometri-

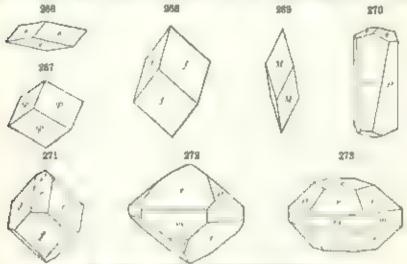
cally but bounded by faces folling in the alternate sectants. Thus the negative form of the aust almost before (0111) shown in Fig. 264 bus the faces.

Above, 0111, [011, 1fe1 bel w [101, 0]1, 101]

The position of these in the project one Figs 288-289 whom the carefully studied that the ingress decay referred to Jugs 264-265, 269 are positive, and Jugs 264-266, 267-268 a garden the mb backers s. Fig. 2\*0 shows both (cruss.)

If will be seen that the two componer are passive and negative the qualitations of given axist ength together pulsace all the ake faces of the death sax said france all parameters of the first order. When these two thou to bedrous are equally touch pell the firm as granteries, y then call with this pyramet. This is alliastic ed by fig. 273 of graduate r 1011.

The triangle of parties of the first order to the first order.



Figs. 265, 271, f ab to Figs. 272, 273, markets of

case the farm which is greater to the a leader tenagen tyromal (in high 273 with a carbon is an last a combar, and the two and thousand couples, possibly a spin angeline. Companyly difference is at his worn the two forms they a character as in high 272 and the view of the first as the possibly a character as in high 272 and the view of the first as the possible relations and the first and a character be established the two chombins by etclang, of, as the present parts by artist to provide the appearance.

149. Of a two serves or zeros, of resolute formula the faces of the pagefive chambahatrons replicate the range by ween the base 1000-15 and the first order press. In the Also the faces of the arguine rhomododorer replace the alternace edges of the same forms, that is, the edges between (0001 and (0115), conspare high 272–273 of the Fig. 274 shows the chombakedron to combine in with the base thing 275 the same with the prism at 1120.

<sup>\*</sup> Quarks serves as a convenient a netration a in case, notwithstanding the fact that R belongs to the trapscoledra class of this decimal.

When the angle between the two forms happens to approximate to 70° 32' the crystal sumula es the aspect of a regular set abedron. This is illustrated ty Fig. 276, here  $c_{\theta}=60^{\circ}42'$ , also  $c_{\theta}=71^{\circ}22$ , and the crystal resembles cassely an occationron with truncated edges (cf. Fig. 117 p. 72



150. There is a very strople relat a between the positive still negative thousied edgers which i is a part of the remember. The rea of our series which truncates the orantal agreed a giver form of the other we have we but is intercept on the vertical error tographic axis of so latter. This rate is expressed in the values of the two figures. This office tran tog the ferr and eages of the pay ive que thembolished that 1014 temperous he terminal origes of tell 25 (1.15) ( 202). rune es the edges of 6221), 4011 of 622 to etc. Dass is these trated by Fig. 271 with the forms ( 1511) and f 02.1 Also in Fig 277. a to see progression with 4 transpose the edges of a office

e til 2) of celli 1 , relitt of a 02,1) 151. Scalenohedran. The metershedron shown in Fig. 278, is the general form for this cass corresponding to the symbol Akil. It is a solal, bournest by twelve were, each a some triangle. It has not give the shape of a diet e aixet ad present but there are two sets of terrainal edges, the more drawn than he other, and the lat ral edges torin a rig Engledge around to form the that of the riombelieuron. It lary by rock lere or dorved from the its regional parished List tool gitte weeming pains of book of that form It is a be noted that the faces in he lower lead of the form do not fat, in vertical rates w, a those of the appearant face the thombohedrous, the sear nohedrous easy be out or pose at ear negative. The positive forms correspond in position to the scalablestron positive the rate hodrons and conversely The positive scalenohedron (2131), Fig. 278 has the following nucleos

ped spill

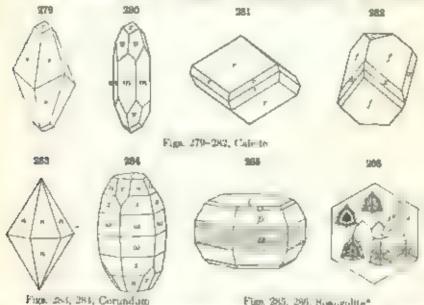
for the several faces:

3211, Abeve 2131, 2311, Berow 1231, 1321, 3121, 2131. 2311.

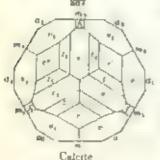
For the complementary negative scalenohedron (1231) the indices of the faces are:

Above 1231, 1321, 3121. 2131 Besow 2311, 3211, 1231, 1321, 3121,

162 Relation of Scalenchedrons to Rhombohodrons. It was noted above that the sea a hadron in general has a series of laguag lateral edges like the rhondachedron it in it, to there that for every rhambabetroe there will be a series or zone of a men-bearons ha og ha men tærstedget. This is known in big. 281 where the malendae ton 2.3. he can be bate an engree of the fun anneanan the enterior run r 1971 the war would be z 1541 beerie the atend copes of the argutive characteristics at 122 The relation of



the inc. we what it must must in these cases may be shown to be, for example, for the chamber he may retail the the first agent of the second destriction and the presence of the parties of t



trains the vortice wanted the act their abstract off. Again in Fig. 292 r 1541 has twice the vertical axis of (0221)

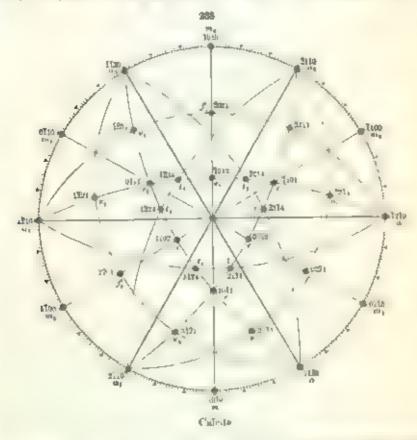
Fign. 285, 286, Homogolite\*

153 Other Forms. The sens using forms of the case which nagrit or expect the normal cases of the rhombohoding disparen are gertal to calls be now of the correspondible case of the here gone, a vis. r viz the lase a not the progress in 1919 at 1120) there's a so as see ope order pyr in ds, as 1121. Separat these is reas are shown in the accompanying figures further plastentions reference may be made to typical rhotabolicital species, as calcae, becase tite, ele-

With respect to the second order pyramid it is interesting to nowe that if

<sup>&</sup>quot; Spangel to belongs properly to the next (hemimorphic) group, but this fact, less not destroy the value of the alustration,

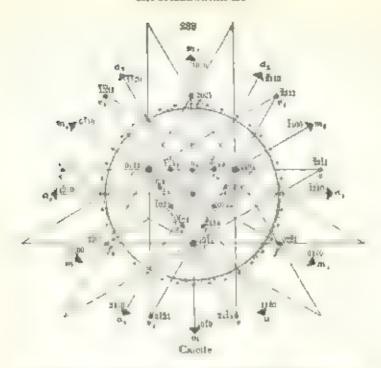
it occurs alone (as in Fig. 283 in = 2243) it is impossible to say on geometrical group is, whether it has the trigonal symmetry of the rhombehodral type or the hexagonal symmetry of the homgonal type. In the at er case, the form anght be made a first order pyramal by exchanging the axial and bagonal planes of symmetry. Ar true symmetry however is often indicated, as with cortact a by the occurrence on other crystas ( clumbe) eded faces, as  $r_{\rm c}3041$ , as Fig. 281 there z=2241,  $\omega=14.14.28.3$ ). Even if



rhombohedral faces are absent (Fig. 295), the etcl-ing-figures (Fig. 296) will often serve to reveal the true true order locular symmetry, here a =

4121 p = 1122

154. A basal pre-pection of a somewhat complex erystal of calcute is given in Fig. 287, and stereographic and gnotionic projections of the same forms in Figs. 288 and 288, both show well the symmetry in the distribution of the faces. Here the forms are prisons, a 11.00 million ob misobostrots, positive v(1011), negative, c(0112), f(0221), scalenohedrone, positive. v(2131), ((2134)



#### 2 RHOMBORF DRAF HEMIMORFIRE CLASS 25 TOURMALINE TYPE

(Introposal Pyramidal, Triginal Rem bedral Remain uph c. or Ditergonal Polar Class)



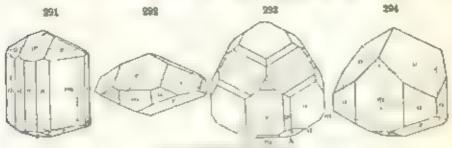
Sympactry of Rhombobse ral Hem morphic

156. Symmetry. Vert Ax-3, 3 vert diag. P A number of promoner the producted spice as, we to true of promoner the product of spice as, we to true of promoner to the group of the fuest inferes at the two extremates of the vertical axis. The forms have the super three diagonal places of symmetry meeting at any most of the interest and symmetry as in the room between axis of the room baxes of symmetry, as in the room bot eductional cases, and there is no center of symmetry, etc.

156. Typical Forms. [1, this class the brand planes or pear a table and ( 800], are the

that forms. The other characterists forms are the two trigonal prisms in 1010 and m 1011) of the first order series also the four trigonal first order pyramids, corresponding respectively to the three upper or three lower

lands of a positive rhombolished and the three upper of three ower faces of the negative rhombolished on the hearth, and the hearth of second order hexagonal parameter, thanks, the four diving man parameter, corresponding to the



Tugs. 291 298, Tourmoune

upper or lower (aces respectively of the positive and negotive sensor desirence. Pigs 291 201 H strate these forms. Fig 293 is a tased second wither, 0111 and c,(1012) below

# 3 TRI-RHOMBOHEDRAL CLASS 22 PHENACTIF TYPE

(Rhombohodral, Tengenal Rhombohet al Rhomobodral Tetartohedral or Hexagonal Altern tray to ass

157. Symmetry Vert Az -5. C It is close directrated by the species of appearing the section of the partial office of the characterized to be seen to a planes.

of sympostry martherers, can don't have of trip tablesymmetry and there is a conter of

symmatry; of Fig 295

of the clam are the rhembolishes of 1 sec ) order on the becaused posses and rhound education, such of the third river. In case a to characteristical by three rhembolishes are the name that types (each + sect...), and hence the name given to it.

The second order rhombohedron may be derived by taking one half the faces of the normal hexagonal pyramid of the second order. There will be two con plementary larges known

Symmetry of Tri-Rhomi-obsdrai Class

as positive and regulary for example in a given case the indices of the faces for the positive and regulary forms are

Positive (above) 1172 2112, 1212 (below 1212, 1112, 2112, Negative (above) 1214, 1122, 2112, (below) 2112, 1212, 1122

The rhombohedron of the third wifer has the general symbol (akti), and may be decided from the normal disexagonal pyramid, Fig. 245, by taking one quarter of the faces of the latter

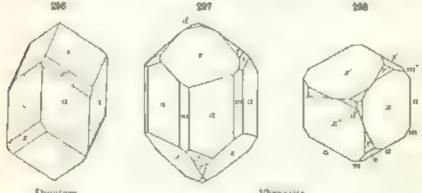
There are therefore four complementary third order rhombohedrons, distinguished respectively as postave right-handed (2131), positive left-handed (3121), negative right-handed (1231). The motion of the sex ake faces of the positive right handed form (2131) are

The herogonal prior of the third order may be derived from the normal difference of prior. I significantly forms known as right- and left-handed. The faces of these forms it a given case (2130) have the indices.

Right	2130,	[370]	3210	2130.	$1\bar{3}20,$	3210
Left	1230,	2510,	3126,	1230.	2310.	3120

159 For remaining forms are geometrically like those of the rhombohedrol class viz. Base ( 0004) first order priors at 1010) second order prism 0,1120), the subchedgens of the first order, as (10.1) and (0.11), ate.

160. The forms of this group are illustrated by Figs 296-298. Fig. 296 is of displace are allows for next-gone prises of no second order 1,1120 with a negative first order regimbs bear in 160221, and the third order thom



Dioptane Phenarite

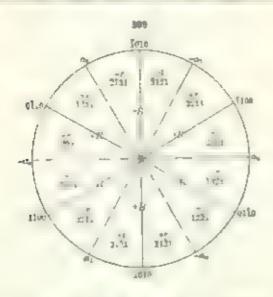
behedron x()311). Figs. 207 and 208 show the chaographic and horizontal proper one of a crystal of phenicite will the following forms first order press month, 0 accord order press a 1120), third risk in misoledrons, x.1232 and x(213) first order zhou bohedrons x(1013) and x(113).

To order to make a case the results of the faces of the inferent types of forms under this case, by 299 is not rel. Here the cases of the positive and begative alon behalf as of the first order are in leaded (+R, 4n + R) also the general positions of the four types of the third order rhombohodrons  $(+r, -r, +t_0, t)$ 

The following solution of the faces of the four rhombohedrons of the third order +r, +r, -r, -t) resulting to the faces of the unit betagonal prism (1910)

_			
Page		_ 7	
PERMIT	N. R. S. T.	TE 1	TPZ

afir a	17	4.25	Inh	E35 t	3211	3.5	2531	,23	1,500	2\$11 110	121 :
		+	100	- 1						+	1 "



## 4. TRAPEZOHI DRAL CLASS ED a-QUARTZ TYPE

(Trigonal Trapezohodrai Trapezohodral Triariohodral or Trigonal Heloazial Class)

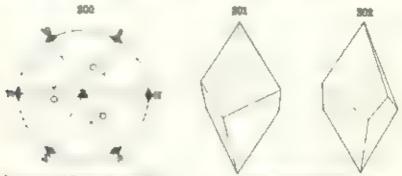
161 Symmetry Vert Ar.-3; 3 hor. Az.-2. The consemelades, among moners a the species points on eminorar. The form over no place of symmetry and no center of symmetry. The territors are as is to we ver in az s of rigorom symmetry and here invaled three courses are of balance are inverse, controlling to direction with the crossing of the extension of Fig. 300.

162. Typical Forms. The chiral error in all as chas is the trage and traces bettern shown in Fig. and. The is in general form a cressional angle the symmethan the faces being a tracted as admission in the accompanying successful projection to a set the faces of this term correspond to on a unser of the taxes. I be a root, liberagues in principles 244. There are a crefore four successful restrictions, two pageons cannot respectively right that less Fig. 601 and for that test Fig. 601 and for the test Fig. 302 and two similar negative forms also rights and reforms of Figs. 301, 362 are countries.

morphoge, and circular polarization is a striking character of the species

betorgated to the class as elsewhere discussed

The indices of the six faces belong up to each of those will be evident on consulting Figs 300, 247 and 248. The complementary positive form to an all of a given symbol near letter twelve faces of a positive scalengheoror, while the faces of all four as a ready stated melode the twenty-four faces of the dihexagonal pyrain d



Systematry of Trapaged odras Class.

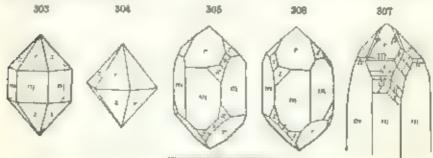
Trigonial Tropicularities

Corresponding to these trapezonedrous aere are two adregonal prisms,

respectively right-and left-handed on \$140 ml (4.50)

I se remaining that after a forms are thought and of this collapse of traposal prior (1120) and (211) also the right of he formed to give a part of as (1122) and (2112). They may be craved by taking respectively one half the faces of the new good prior of the seven parts (1120) and (1120) are of the corresponding prior of the seven parts of the seven problem.

163. Other Forms. The other forms of h cause are geometrically like a set of a regard the minder rot case. They are the best (0001), the hexagonal first order position (01), and the position indirect very relative drive as a left and (011). These are not be distinguished geometrically from the normal forms.



Figs dist- 107, Quarts

164. Illustrations. - The forms of this lass are best shown in the species quarte. As already remarked ip. 122), simple crystais often appear to be

of normal hemeonal symmetry, the sharebohedr as - 10 1) and z 011 being equally developed 1 gs 363 364). It can be seen and or a differpose in molecular character is ween them can be propert in more comthe als the rhendrolastron toll product the product to the district to cult hands be been a dispersion Survey to here this gran is east. Iving faces the got traget, present said with a high tactripose heatron, as a rail to the the area of the state of the present to plane of personance of leg o transmit of a the direct or a treater of tax of the right A creat I had by 300, while he by a partition \$[211] and ere or rate and rest into each in excluding the chall at the regards agt tous to appear of the error of the error, of tag and Fig. 307 shows a non-x applex relationed rest. v - versi por a and register the abstractions where positive right trapezol of the abstraction negative left trapezohedron, N

The terming we be shown by perhaps a ste from it is far from zelocite to see a recomposed will the constant gold pur govern if Art 160, of root do I the place a copy to the government five form a sense not ners profer to a ske the faces 21 ( 12 ) and ght, who

3121, 1321, etc., left.

### A ARTY TRANS

										21 th	
3 2E	-1 21%	47	41	-r 200	-1 3m	1 1 1	21	123T	150	31	JŽ I

### 5 TRIGONAL TUTARIOREDRAL HOME MORITHO (2) SODIUM PERIODALE TYPE

(Triguest Pyram del . T area I' at hara

165. The last of see of this ways of one I plane of expres ry as I me confer of express and the same of the same of the same many The ference upon 1 to your a no pre the trigen of a term to const Persolating to the transfer to the same and the land to the known mineras beat gat has eles-



### MATRICK TO IL RELET SO OF THE HEXIGENIE STRYEN

the charge of Axis. In case, the series of a series of a series of the series. The box of the series the series what a green or name in Constitution up to to his or what he was a second of the home agreeding on which of the wilmost a continuity places is a tracery is taken as the about 100

187 Axid and Angular Staments. The axid element is the length of the vertical axis, a memory of a hit in a larger of a three words the axis in a discontinuous state axis and a larger a grant of a translation of the south axis of a larger translation.

The que to prome a program of the angle between the base cropped and the

and a company of the last term of the

yor plant, becopen to a negletand the axis to piven by the forential

$$\tan (0001 \land 1011) \times \frac{1}{2} \sqrt{3} = c$$

The vertices are a sho easily illustred from the and second or ter parameter, since

These read has become general by writing them so it lower

tan (0001 
$$\wedge$$
  $h0hl)  $\times \frac{1}{2}\sqrt{3} = \frac{h}{l} \times \epsilon;$   
tan (0001  $\wedge$   $h^*h^*2h^*l) = \frac{2h}{l} \times \epsilon;$$ 

In general the result to a statio stay required angle between the power of two factors of the adjustment of the period to the pe the reader of a co o a new taget cagoe

The large of teas of his regood in any some 163. Tangent and C tangent Re ata as

from 100s, to a face of representative to be a count

In the primulate some, the congress form his taken a morphise from the example, for a three agencies print to the will an willing

cot (10Î0 
$$\triangle$$
 Ale0) =  $\frac{3\lambda + k}{k} \sqrt{3}$ ;  
cot (1150  $\triangle$  Ale0) =  $\frac{k + k}{k - k} \sqrt{3}$ .

The tar of the angles of A AASO and all A Acid area is 6.30.

particularly angular price of the particle of the first and the particular of the pa

0.710

Also amilarly for other somes,

158. Other Angular Relations. The following simple relations are of frequent use [] For a heargonal paramed of the nest reder

tan i .toIt o offi - am ; V j. where tan t = c,

and in general

12 For a heangonal pyramut of the second order as 1,22.

(3) For a rhombulation

(n. general

170 Zones Relations. The about on the new of the free 80 EL sports before in their spaces of a facilities of a facilities of the spaces of the spaces of the facilities of the facilities of the facilities of the facilities of the spaces of the s May eet on Take He sectors

where

$$u = ht - tq$$
,  $v = tp - tu - u = hq - hq s$ .

but error de 1 g 254 the luce a new hor soo me OF MA are ment at the repet att. A set for the test but o he so a see a real or the mrs - 1 zono r = 1, f - 1, y - attenting and the resident according to the attent no ben ne



The face a has, therefore the a horse Old sin - f : t. A + t.

171 Pormotes. The following on the protect regard the unit length of the vertical as a are nometimes useful.

1. The patterns over tig. 1. If the pole of also face, but a from the poles of the faces

1010 , 0) 0 , I to an the are given by the has a tig equations

$$\cos (kkst) \cdot (010) = \frac{cfk + 2k}{\sqrt{c^2 + 4a} + a + k^2 + kk}$$

$$\cos (kkst) \cdot (0110) = \frac{c2k + 4c}{\sqrt{c^2 + 4c^2 + 4c^2 + 4c^2}},$$

$$\cos (kkst) \cdot (010) = \frac{k}{\sqrt{3^2 + 4c^2 + 4c^2 + 4c^2 + 4c^2}},$$

$$\cos (kkst) \cdot (0001) = \frac{t \sqrt{3}}{\sqrt{3^2 + 4c^2 + 4c^2 + 4c^2 + 4c^2}},$$

2 The distance PQ between the poles of any two faces P(kkiP and Qipper) is given try the equation

$$\cos PQ = \frac{2c}{\sqrt{3P + 4^{2}}} + \frac{2e^{2} \cdot hq + pk + 2hp + 2kq}{k^{2} + k^{2} + k^{2} + hk + 3P + 4A^{2} \cdot k^{2} + q^{2} + A}$$

3. For special cases the native torm da becomes simple had—a server to give the value. of the next of a good of the sources of orms in the system. They are a fallows a Pyramid of First the health in 180m. Fig. 242.

b Pyromul of Second Order is h 2k D, Fig. 243.

con Y (terrostral) = 
$$\frac{p}{p} + \frac{4e^{2}h^{2}}{4e^{2}h^{2}}$$
 | qual S (banal) =  $\frac{4e^{2}h^{2} - p}{h + 4e^{2}h^{2}}$ 

(c. Daharagamal Pyramus hkil)

cos X free Fig. 244) = 
$$\frac{3h + 2c^2 (h^2 + h^2 + 4hh)}{h^2 + 4c^4 (h^2 + h^2 + hh)}$$
,  
con Y are Fig. 244, =  $\frac{3h + 2c^2 (2h^2 + hh + hh)}{3h + 4c^2 h^2 + 1^2 + hh}$ ,  
from X Dana =  $\frac{4c^2 (h^2 + h^2 + hh) + 3h^2}{3h + 1c^2 h^2 + h^2 + hh}$ ,

(d) Dilampenal Prium (hkt0) Fig 240

cos X axial = 
$$\frac{h^2 + h^2 + hh}{2(h^2 + h^2 + hh)}$$
 cos Y (diagonal) =  $\frac{2h^2 + 2hk - h^2}{2(h^2 + h^2 + hh)}$ .

(a) Rhombohedron (1011)

(f) Scalenohedron (Akti):

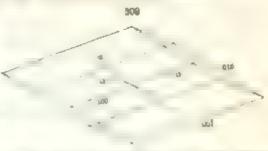
com 3, see Fig. 277 = 
$$\frac{8P + 2c^{2}/2k^{2} + 2hk - A^{2}}{3P + 4c^{2} h + k^{2} + hk} = \frac{A^{2}}{4k^{2}}$$
  
com 3 (see Fig. 277) =  $\frac{4P + 2c^{2}}{3P + 4c^{2} h^{2} + k^{2} + hk} = \frac{4c^{2}}{3P + 4c^{2} h^{2} + k^{2} + hk} = \frac{2P}{3P + 4c^{2} h^{2} + k^{2} + hk} = \frac{2P}{3P + 4c^{2} h^{2} + k^{2} + hk}$ 

172. Apgles. The argue for some common y occurring talexagonal relains with the first and second order prisms are given in the following table

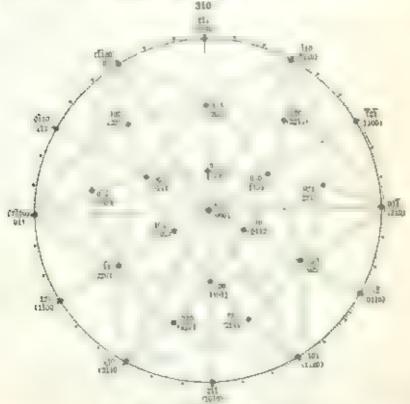
	ey(1010)	a(1120)
6)60	8" 57'	231 31
\$150	10 - 61	20 (1)
अवि	13 (4)	16 6
5.70	16 6	18 54
2170	10 6	10 534
1.50	27 241	0.351
5890	20 [11]	3 40

178. The Miller Ages and Indices . The forms of the horogonal evotein were referred his More to a set of time or all it may also which were also put to a tax every fitting and summer characteristics of the species. The 300 represents their of anisable con with of persons that several see the laces of he agree form are not research to be two sees of 1. Werent in laces for example for laces of the arminal of the art work work are the masses, 100, 227, 510, 122, 001, 12. Thus a period becover, many pears of the bluer areas is distribute are used only for formula. The filters in helical physicism what is, for himse belonging to a cases we see size characteristical in a vertical and of imposed eventuery. It is be-

ing to a mass we are characters hered, he were his he mutual relations of an the engine of both divinous of the hermonal system among a measure or also to the cases of the transfer of all systems, but more a profit of a large of the system of the system



the same of a contract of the same of the



Miller san M. are Fra also whose Compared

tuit poets to remember too have the indices 100, 010, and 002 and times of the negative combalf remodels or have 110, 011, 101. The base prism of the red copy of retree neithed by 211, etc., while the second order prism has of, etc. The ametagonal pyracod

tun two cets of the lives said an effet of these the a reliad of the ungular to the team of because the state of the negative term. In the as in which cases it is for each to be a but the first of the form of the first of the form of the first of the form of the first of the first of the form of the state of the stat (2131) while the complement and we will have the second of the The red to a warren the Motor beautiful and the the second attention to the terms for in a first case be

obtained from Colotions, gespirosoms, where had be created to east the pay the second

The relative between the Moser without it has ground broke and those of more strucforms should be no cut to we when you is no moments on as a consequence of 90° and

31 L

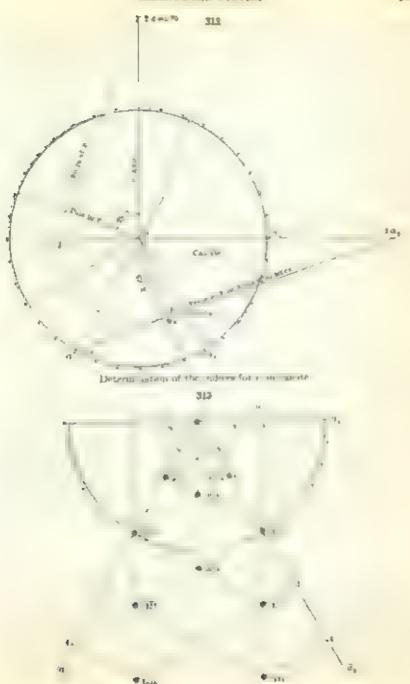
present at in af unit length of guess, having given the points of a 1011b

to test and in the set beets face 11) we can seek it steg to me surrey a decre be takent for W.

174 To determ be by plotting, the length of the vertical and of a becogonal deporal. given the post in in a rainer graphic propertion of the poin of a face with known ad ces I'm I street the or horse of all was been but his course in e i pi ser de al lar pe i pi tiur pede y l l l se ar we for l la tue rese he wet promised they up to one or a the case of the orribe. Draw a line from the senter of the projection through the pole p. Draw another line techt a will be at right a give for or orst product the depend much a classylther . ted and the strong respect to the h the eight of the T spot blue I'm H H June 10 4 pp area it e tana and com-

transfer of the big central is gire the higher the boar for him there is a first to boar the hard of the a chief press of the expension has been as on or as a way be above of the hard of the armonic point we area. The hard area of the section to an order prompt of the many to the transfer hards making the section to the region too the pole of a his case how every contact and of a carry the very which equipments Manner's quest if it earlies the night is no horse over name which equipment 0.00 governor to be as longs of the loss of the best

175 In de empire the indices of a face of a heregona form of a known to nemt, given the position of a pole on the storongraphic projection in fig. 5 / new relativities specified of the policy of a constal face to a discussion of the policy of a constal face to a discussion of the policy of a constal face to a discussion of the policy of a constal face to a discussion of the policy of the pol the end of the setting the third place is a lithest event acceptant in the set of edge of the statement the end of the statement in the set of the statement that end of the statement is the set of the statement that of the statement is the set of the statement that of the statement is the statement that extract the statement is the statement of La determ on the column is terrory in the case expenses he is among the this giver left hand quantum of the figure, then having encourse, he may do dieter a server, the content of the properties and a by threese of the eterophraphic professor draw the poin to the face



to the proper pose can. Throw then a set a ng it squeeto the pole stating from the party of a set of great to a man of a set of set of the special state and the set of the special set of the set of the special set of the s

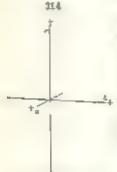
176. To determine by picting the discrete I because, forms, given the position of The state of the property of their poles to the garman are pro-exhabit 1 F 7 10 the fre to 1 m - my think p 150 16 Vot of P T T A CONTRACT - opposite P more in given no to the same area. no the tree here to the to the total figure. , , u , , , , , 

177 To determine the arms, rate of a being na orders, from the greenous projection of its forms. The green of the green of the green of the green of the night in the night of the green of

#### BY, ORTHORHOMBIC SYSTEM

(Rhombie or Prismatic System)

178. Crystallographic Axes. — The orthorhombic system of below all the forms which are referred to three axes at right angles to each other, all of different lengths.



### 1 NORMAL CLASS (25) BARTLE TYPE

Certharbanhic Axer Baribo Ortho hante It parame at Hanhedral in Didigonal Equatorial Class)

178 Symmetry 3 al. Az-2, 3 al P. C. The first of the cormula class of the orthochombic system are managed by three axes of on art 5) manutry, which directives are compared at the crystal agraphic exes

<sup>\*</sup> The prefere to the state of the critical aparticular and also in the tricking aparticular attention the critical aparticular and a supplied to the tricking aparticular apar

There are also there unlike planes of symmetry at right angles to each other

in which do the crystal ographic axes

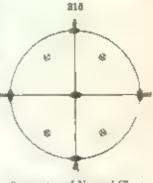
The symmetry of the class is exhibited in the decompanying stereographic projection for 315. This should be compared with log 109 up 69; and Fig 185 (p. 93), representing the symmetry of the normal classes of the isometric and tetragonal systems respectively. It will be seen that while normal isometric crystals are developed alike in the three axial directions,

those of the etragonal type have a like accelepment only in the direction of the two horizontal axes, and those of the orthorhambie type are unities to the three axial directions. Compare also Figs. 110 (p. 71–189 (p. 95) and 316 p. 140

180. Forms. The various forms possible

in thus class are as follows:

4	Macropinacoid or a-pitacoid Brachy pitacoid or b-pinacoid Prisms Macrodomes Brachy fomes Pyramids	(100 0±0 (001) (Ax0 (A0I) (9xl) (Axl)
4	Pyriamida	Crexces



Symmetry of Normal Class Orthorhombic System

In general, us defined on p. 47, a panaco a malform whose force are parallel to two of for axis, that is, a no said pinar a priorition no whose area are parallel to the vertical said, and therefore the two in a malform of a non-small, when is one whose area are pure less of the horizontal axis, but intersect the vertical axis. A pyriamic is a form whose faces a set of the three axis.

These terms are uses a the above sense or trady in her orthodowns a stem, but also in the membelianc and tricking systems: in the met cash form commute of two planes only.

181. Pinacoids. The macroparation includes two faces, each of which is parallel both to the macro-axis b and to the vertical axis c, their indices are respectively 100 and 100. This form is uniformly designated by the fetter a and is conveniently and briefly carried the reflect or the aspiration.

The brackground ucloses two faces is a distance is parallel both to the orachy axis a sult to the vertical axis. Any have the naires 010 and 010. It is form is designated by the letter b, it is called the b-face or the

b-penacoid
The base or basal pronound includes the two faces parallel to the plane of
the horizontal was, and having the indices 001 and 007. This form is design

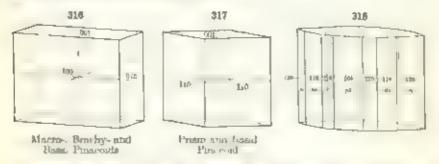
nated by the ister e, it is called the especial the especial

Each one of those three panaeoids as an open-form i but together they make the as-called diametral prism, store it big 316 a solid which is the artifogue of the cape of the asometric system. Connectically it cannot be disanguished from the cape, but it differs in having the symmetry unitie in the date axis, directions thus may be shown by the make physical confector a the mass a b, c, for example as is linear, structure, etc., or, again, by the consumer. Further, it is proved at once by opened properties. This

<sup>\*</sup> bream the Latin domor because resembling the roof of a house, of Figs. 319, 320, † See p. 48.

d ametral prism, as just sisted, has three pairs of unlike faces. It has three body of edges four in each set parametrespectively to the execute hands of the same amount are uniterarily made to correspond to the routive lengths of the chosen axes, but the student will an irretand their a crystal if this shape gives a information as to these values

182. Prisms. The prisms proper idelide those forms whose faces are parts. It the vertical axis, while her intersect both the nonzental axis, their general symbol is, therefore, that These all belong to one type of thinday grasm in which the interfacial angles corresponding to the two unlike vertical edges have different values.



The unit prism (110) is that form whose faces intersect the horizontanixes a lengths triving a rate corresponding to the second condition of a to been the given species in other words, the align of this indipensation the crit lengths of a corrected axes. This form is shown to embedd on what the lengths of a corrected axes. This form is shown to embedd on the length product of Fig. 317, it is an errory design to by the let or in the four trees of the anti-prism trive members 110–110, 110.

Here is, if a true a large is the end other possible prises whose at recepts spin the hitzontal axes are not proper or stero their unit sengths. These may be divided into two classes as fillows magraphenus, whose fixes so the ween those of the macre phospoot and the area paint broken prisms of faces between those of the tracing face of and the distribution. A proceeding, has the general symbol had to which k>k in the approximation of the first plane of the k and it is a presented by the first  $k \ge k$  and is represented by a 1200 fig. 318.

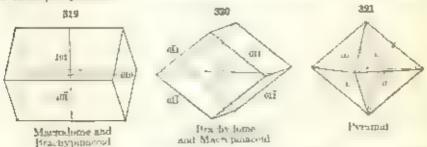
183. Macrodomes, Brachydomes. The macrodomes are forms whose laces are parallel to the macro-axis by man, they between the terrois axis c at 4 the horizontal axis a forme the general sym as their form as the main line and me, all have the record the axis a. The form as the main line 319 combined space is a per form as the best spacecoal.

In the marrodome sear between the base cool and the marropose of a 100 there may be a large a unber of marrodomes having the symbols taken in the order named. Lot 1.02, 1203, 104 302, 254 301, etc., of Figs 336 at 1347 lescribed later.

The he conviouses are forms whose fires are parallel to he brothy axis to whose they are seed the other axis c at 1 b. their governed symbol is that The argor of the man brackyd are the fire, which is shown with a (100) in Fig. 320, determines he note of the axis b. c.

The brachs dome zone between c(001) and b(01)) includes the forms 013 (012) (023) (C11) (652) (C21) (031), etc. of Figs. 336 and 337

Both sets of domes are often spoken of as horizontal prisms. The proin they of this expression is obsidue, since her are in fact prisms in genpretried form, further the choice of postton for the axes which makes then domes, astend of president the narrower sense, as more or less arthurary, as aready explained



184. Pyramids. he pyrama is in this everem all belong to one type. the double ther are pyrusad, so it ded by eight frees each a scalene triang is This firm has three simils of edges, x, y, z 1 g 321 each set with a different , perfected a gar two of these angles suffice to determine the axia ratio The setator for that the general form for the system is had

The pyramius may be divised into three groups corresponding respecvery to the three prisons just described manney, and pyramule, macro-

pyrounds at I brack pyrounds

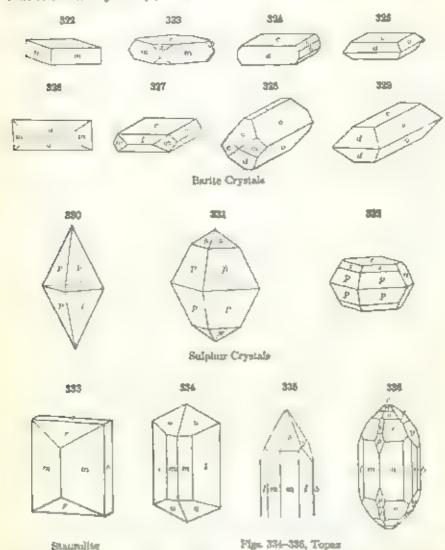
The and purus ds are characterized by the fact that their intercepts on he hor zontal exes have the same not as these of the unit prism; that is, he assured axial ratio a h for the given species bor them, therefore

the general avin at becauses and

There may be different and pyramids on crystals of the same species with different intercepts upon the vertical Ans and these form a Lora of races aving between the base, wil out the net press on the sone would ref de the forms, 1.18 (117 (117), 114, (1 3 112) (111 la the by a bol of  $x_i = i$  the form of this zeros  $\theta = k$  and the lengths of the vertical axes are hence in the example given, | \$ 1, \$ of the certical axis c of the unit pyramid.

The man you am its and brook, a gramete are related to each other and to be use parameds, as were the in a reprises and brachyprisms to their eraces and other and they be refer and vertical come of macropy market for brichyperan ds I mang a come a ridio for the herizontal axes (or f h k to me symbol belongs to a particular macroprism sor bracis prism characterized by the same train. Thus he macre per ato de 2-1, 213, 212), 121), ore, a leasing to a common vertical arre be ween he base 001) and the prastic (2)0 San far v the bracky pyrainius (123 (122 , (121), ,241), etc. for a relate of ver cal zone hotween (001 and 120

185. Illustrations. The feel wing figures of barite 322 320 give exrefact their tems of createds of a type a charle make species, and show also how the habit of one and the same a some may vary. The areal ratio for this species as  $u_0 = 0.815 + 1.314$ . Here u is the quarticularity (102) and of the brachydone (111), mass as always, the prism 1101. Figs 322-125 and 327 are described as tarocher at 401. Fig. 326 as prismatic in letter in the direction of the inner axis (b) and Figs. 328, 329 presents of that of the brachy-axis (a)



Figs. 336-332 of native sulpher show a series of crys als of pyramidal habit with the dame  $n_i(0.1)$ , and the pyramids  $p(\cdot,1)$ , a 113. Note a runcates the terminal edges of the factor into pyramid p. In general 4 should

be removibered that a macrodome truncating the edge of a pyramid metallayer the same ratio of k = l thus (20), truncates the edge (-1, 221) etc. (21) and any of the bracky-domes (02) transities (23)

the edge of 22.) etc of high 17 336

Again big 333 of stauren r shows the paracolas 50010, e0001 the prism on 110 and the macroslome r 101

Figs. 334-336 are prismatic crystals of topax. Here is the prism 110 - l in . so are the prisms 120: 140 - a and a are the macrolomes (201 and 40) - j and , are the orachy forces (211 and 64) - i, a and sure the optiones (23), (411 - 221

and gnomonic projections are given in high 337 339 for a crystal filter sports opens

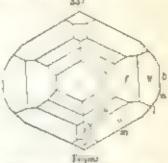
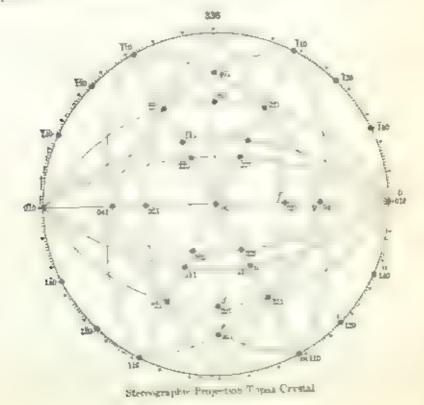
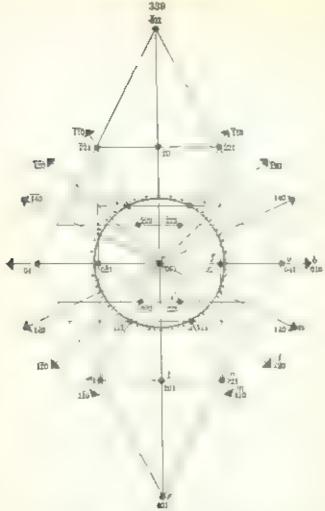


Fig. 337 to the basal proper on a the cross of shows in Fig. 338. Figs. 338 and 339 give the stereographic and ghom has proper tons of the forms present upon it.





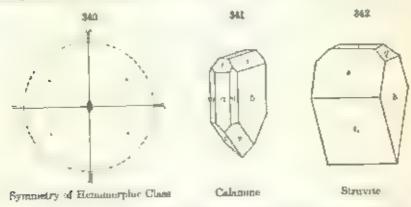
Gnomenic Projection Topas Crystal

# 2 HEMIMORPHIC CLASS 26 CALAMINE TYPE

Orthorhambic Pyramidat or Didg mal Polar Caps

187 Class Symmetry and Typical Forms. Vert. Ax. 2; 2 vert. xl. P. The forms of the orthorhombe-ben complete class are characterized by two are key and of symmetry and the exist of their symmetry, the letter they otherweet, there is no center of symmetry. The forms are therefore bending the as femined in Art. 28. For example, if as is as not with case, the vertical axis is made to axis of symmetry, the two planes of symmetry.

are parallel to the paraconic at 000 and 5(010). The pressua are then geomethically like those of the normal class, as are also the querophoconic and trace vipiture and, but the two used planes of pedicus become inteperation forms (001 and 00). There are also two microscomes. If i) and (101, or in general 500) and 556, and similarly two sets, for a given symbol, of brachydomes and pyrounds.



The general symmetry of the class as allown in the stereographic projection Fig. 540. Further Figs. 341, of character, and 342 of struvite, represent typical crystals of the class. In Fig. 341, he forms present are #3017, hU313, h(1217, in Fig. 342 they are s 101), a (1011, in U11).

# 3 SPHENOIDAL CLASS (27) EPSOMITE TYPE

(Orthorhombia Disphenoi tal or Digonal Halanzeal Class)

188. Symmetry and Typical Forms. 3 xl. Az -2. — The forms of the remaining class of the system the orthorhomist-aphenoidal class, are clust-

acterized by three an its recongular axes of Laurev symmetry which coincide with the crystalographic axes, but they have in plane and its center of symmetry (1 g 341). The general form tall here has four faces only and the corresponding solid is a rhanbic spherical, analogous to the spherical of the testingenal system. The completion itself and system. The completion itself positive and negative aphenoids are enantiomorphous. If g 344 represents a typical crystal of epsomate, with the positive aphenoid, a 111). Other crystals of this species often an which positive



Symmetry of Sphenoutal Class Epsounte

of the species often at wheth positive and negative complementary forms, but usually unequally developed.

#### Матниматили Вальчнова от тик Онуковновние Вустав

189. Choice of Axes. As my great in Art. 179, the three crists bigraphic axes are form as my or a present or has more and a re-small full days and of here may be made he vertical and, and of he we at a cores where a the greet in which he shall be a different at the person of the person of the content where been to manage an in order between a content of the person of the colors.

The true a great of the greet of the colors of the person of the person of he

orest fille on the first that the terms of the first boundaries on the contraction of the first boundaries on the contraction of the contraction o

WELL AL THE

190 Axial and Anguar Elements of the committee with the ratio of the lengt and the tree name in terms of the macrosians, how much year example with hardie the axial rouge is

$$a \cdot b \cdot c = 0.81520 \cdot 1 \cdot 1.01359$$

The agreed demonstrate agreements when as the angles between the three personids and the unit was a the three source between about. Thus again for burite, these comments are

I not of these anglest sharehed intercome the U of angle as well as the gala ratio. The degree of as and I have ten all the six or a fitter as if the as it to a some be tampered the make of the end of the ward bathar awhere well on There is to great remove to a good for a read . In to make the product in prove the imparited with aftern to the above the towards of the the base content could be a content to a few seconds. It is not the China ever to have the ring in a lattice to correct was within the got that the oper asterling est decades from the say but cars from those person, direct from the measured angles by query har gray to 1

191 Calculation of the Axes. . The following ample remained (cf. Art. 63 connect the

gree into the dago at esemente.

$$\tan (600 - 11.0 - a) \tan (601 - 011 - c) \tan (601 - 101 - c)$$

These equations serve to give either the axes from the angular elements, or the angular element in thin, the axes in it is seen that the axes are not unable for any play reasons all - "A or at the same and the total them for example to use in our paring her

trivially at in the advance of a land of the recognitive designer, concurred an the basis of ender the tion it is not be never thought by he couldness much as now to be stignished one ment in from maker to are of my my his his any nor in if the transport principle ( but 64 to be used on right atch to the said and the right-angled epitionical francisco given

the spines of the three games 100 and 36 010 and 200, 301 and 260. For was after the new one other time of a tree of the new one of wood the pulse. 202, 012, 310,

are linewe. These are are go at respectively to the extenses

$$t_{\text{Bin}} (001 \land 302) = [ \times t_{\text{Bin}} (001 \land 101),$$

102 Example Ing his represents a crustal of stimule from Japan and Fig. 340, the a crusque, in crust of the case in the second state of the control of the case in the case of a pro to his he following commend as give were taken as announcertas.

$$\mathbf{m}'$$
 (363  $\wedge$  353) = 55° 1°0°,  
 $\mathbf{m}''$  (363  $\wedge$  353) = 90° 39°0°.

Henry the angles 357 \* 017 - 10 114 and 353 \* 053 = 27 304 are known withcost all no us. The right region is been a many of 0 fittin tool sheet by langue 010 5 6% and better 001 to make he might at 050 which is equal or 001 5 will

<sup>\*</sup> The steerest on the best of event of the characteristic cross a projection of the 1866 trust reservery viate at a reservoistes to the above dividing approximately, the relative position a the faces present

But tap (001 A 011 = { x tap (0) | 0 050 and tap (0) | 0 010 = c. Also, since Ian (001 A 101 = the axion rutes as thus known, and two of the angular elements

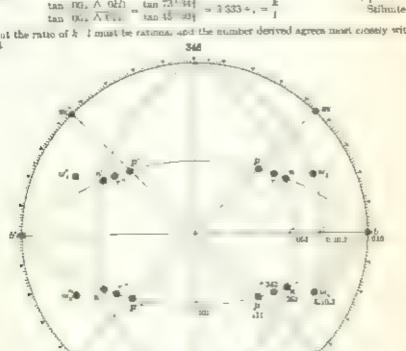
The third angular element 00, " | I can be encolated independent y

for the ange at 001 or be transpored to the care at the care at the care at the tan 01. So the proof of the content of 100 the care at the a man at a right angle, transport and arrest give and instead langue

from so her he fundamenta angles and to the the a constraint to again, the south of any date we are on the read the read on if two mensured angles of a serable according are at many for example, our the face w. suppose the measured states to be

The solution of the triangle tro-Oid gives the angle (0.0 A Oid. = 10° 25 M'', and

But the ratio of \$-1 must be rational and the number derived agrees most crossly with 10 3



Strengtraphe Projection Stabule Ceretal

Age o, the angle 601 A AN may may be calculated from the earne triangle and the yange 50 385 objected. From the the rate of a 5 in ferroso asset

top (001 
$$\triangle$$
 A01) = top (59° 288° = 1-945 =  $\frac{A}{1}$ 

This ratio is nearly equal to 5. 3, and the two values then obtained give the event of 5.16-3. If, express from the estimate 0 is  $M_{\odot}$ , the angle 0 which is one which, the rate  $M_{\odot}$  is obtained, which is asset the angle 0 10  $\wedge$   $M_{\odot}$  is from this the ratio h is independent exact.

$$\frac{\tan A010}{\tan A010} \wedge \frac{11.5}{A00} = \frac{\tan A5^{\circ} 120}{\tan 26} = 2.002 = \frac{k}{\lambda}$$

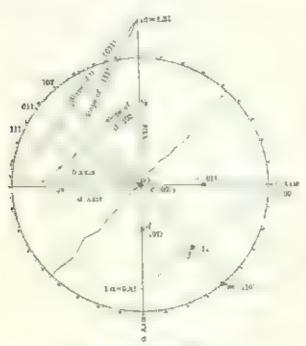
The value of  $\frac{k}{k}$  is hence closely equal to 2, thus combined with this first obtained  $\binom{k}{k} = \binom{k}{k}$ 

Fire a ded name where then usually complex calls for fairly are into measurements.

However, must be a role whith set is run ten be, good by comparing the measurements with hose role date, from the symbol. For example, a the given case the consideral names of the role of are role of the role o

It will be megationed further that the sound relations, explained on up 61 64 play as important, as we all one and one. For example, in Fig. 345 of the same for were measured, it could be obtained from a single enginees. Since for this zone him is

347



Determination of the Anal Stack for Barde

183. Formulas. Although the not often necessary to employ through a religibilities, a few are added nere for take of our plateness. Here a and can the form our are the lengths of the terrance a our a

(i) For the distance between the pole of any face Polish and the phononics of b. c. we have in several.

and 
$$Pe = me^{i - h k l} \wedge 100^{i} = \frac{h^2 e^{i - k}}{h e^{i - k}} = \frac{h^2 e^{i - k}}{l^2}$$

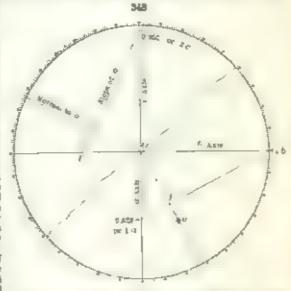
cont Pb = cont (bld 
$$\land$$
 0(0) =  $\frac{M_0^{1/4}}{M_0^{1/4} + M_0^{1/4}} + Pa^{1/4}$   
cont Pc = cont (bld  $\land$  001) =  $\frac{M_0^{1/4}}{h^{1/4} + h^{1/4}(a^{1/4} + B_0)}$ 

(2) For the distance PQ) between the poles of any two faces his and (pgr)

$$\cos FG = \frac{h p e^2 + k q a^2 e^2 + r a^2}{\sqrt{[h^2 e^2 + k^2 a^2 e^2 + r^2 a^2]}} = \frac{h p e^2 + k q a^2 e^2 + r^2 a^2}{\sqrt{[h^2 e^2 + k^2 a^2 e^2 + r^2 a^2]}}$$

194. To determine, by plotting, the axial ratio of an orthorhombic crystal, having given the stereographic projection of its forms. In order to edge the problem is a socre-survith the postage of the pole of a pyramid face of known manners be given at the post of of the faces of a prism and one dome or of orth a manner and a braw to force. For distribute it is assumed that a crystal of hards night a represented in Fig. 123, has seen together on the government of the faces plotted in the stereographic project.

tion. The lewer right hand qualmet of the projection in above in Jug 547. The Format present are remained ones on barrie crystale and have seen gram the extends m 100, d 132 00011, c 301 The esta of a bona be entermined read by from the position of the trole in 110. A radial time is drawn to the pole of the face and they a perpent count erected to a from taken I of the coveregoe. emiting the 5 covers agraphed axis. The operage of the perpen acolar in the increpresent ing he alone when expressed it exist if the assessment dist. length of the e and gives the reagth of a lit not be noted that the fact that the ane di the series these present very now to he ugh the rade 111 is who fly are to the The singsh if he istendants can be usterm nest from the poets of of the pute of either 1 PQ or a 01. The sustainment used as give as in the paper few time. I

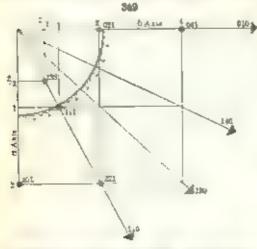


purifying if the tig so if the tracky oppose will, in secil the sloping line that gives the new rate of the lace as smetch for a historic country to his received to the consequence of the consequence of

The steeres as is have been wheats solved from the points in of the press of there 111 if have arise to been a court to be executive. The construction is thus not a substituted

198 To determine, by plotting, the indices of a face upon an orthorhombic offstal, given the practical of his pole upon the steerographic projection and the axial ratio of the mineral. It is not the problem of determine that the posts of in the pole in the place in the face, a beginning that the posts of the pole in the note in a set of the pole of Nerthern a neglect the art from the strong of the or about the pole of the constitution when the pole of the constitution of

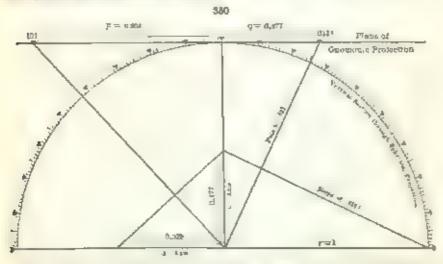
and to the face is determined by measuring with a protractor the angular distance between that is, The line giving the slope is the face is sext frawn percental far in this normal and its intercept upon the bar representing the vertical axis determined. This instance



when expressed in evine of the leigth of the baxis of 0.5. This is twee the established leigth of the caxis 0.470, and consequently the third parameter of the face of 2. This given the masses 22, for the face

196. To determine, by plotting, the amal ratio of an orthorhumbic crystal having given the gnontonic project on of its forms. . issleafe to a probago the gramonic progression of the crysta of topax already given in Fig. 339 was be-In Fig. 339 she paidment of this projection is reproduced. From each pole a near are drawn written the gur to he two bree re accessing the a and b crysta begraptue axes. at will be found that the a process note to this way a wir or a last have intured relations to each other The same is true of he astoreepts mon the 6 ame. The interrepts upon the two axes however are

at the the exempts agent the major to the expressed in terms of the right of a to the expressed in terms of the right of the expressed in terms of the right of the two to the the expressed in terms of the right. Of the the the true of the true of the expressed in terms of the expressed in terms of the expressed in terms of the true of the expressed in the expressed in terms of the expressed in the expressed in terms of the expressed in terms of the expressed in the expressed in the expressed in terms of the



If we abor an entire that the transmost distribution and either the properties, and equal to be chosen interests from the first distribution as an approximate per that can be derived true the fall was expressions:

$$q = c; \quad \frac{a}{c} = \frac{r}{p}.$$

The proof of these relationships is sum for to that already given under the Tetragonal System Art 121, p. 100 and is limitarized in Fig. 350 for he case of topics. The position of the pole of the face 1011 is shown to the right end of the tangential one representing the pole of the granus projection. The line giving the sit period has given the unit tength of that can interest upon the ine requestions the related has given the obtilength of that can. The two right-langue transper shows on the right is not may of the figure are side tend and greaters a Summarb on the set but and of the figure he possible to the late of his face articles of the contribution of the large and the figure are similar and therefore the values of a said of are proportions for rangles is the anal of the figure are smaller and therefore the values of a said of are proportions for rangles in the anal of the figure are smaller and therefore the values of a said of are proportions for rangles.

197 To determine, by plotting the indices of a face upon an arthorhombic crystal, given the position of its pose upon the gromanic projection and the main, ratio of the mineral — The method of course who is the case is the territor of the given to the pre-critically be before an agreet, most the low nature on 1 Terraguna, Stepas Arts, 88 —1122. In the case of an orberhoushe maneral the a creepts of the perpendicular area or now from the pole of the face to the a agod bears must be expressed a carbonase to terms of the unit is terrept no court was. These values, pland q, can be determined from the

rountions given in the proceeding problem.

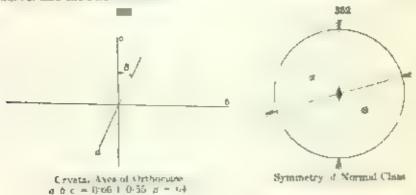
#### V MONOCLINIC SYSTEM

(Oblique or Monosymmetric System)

198. Crystallographic Axes. — The monochine system includes all the forms which are referred to three unequal axes, having one of their axial

inclinations oblique.

The axes are designated as follows: the inclined or chan-axis is a; the ortho-axis is b, the vertical axis is c. The seate angle between the axes a and c is represented by the letter B; the angles between a and b and b and c are right angles. See Fig. 351. When properly orientated the inclined axis, a slopes down toward the observer, the b axis is horizontal and parallel to the observer and the c axis vertical.



# 1 NORMAL CLASS (28) GYPSUM TYPE

(Promatic Hotoke tral, or Digonal Equational Plans)

190 Symmetry. b zl Ax.-2; a-c zl. P; C. — In the normal class of the monoclinic system there is no lane of symmetry and one axis of binary symmetry somment to it. The plane of symmetry is aways the plane of the

ance a and c and the axis of symmetry countides with the axis b, normal to the plane. The position of our axis b) and that of the plane of the other two axes a and c is thus fixed by the symmetry, but the information occupy different positions in the plane. Fig. 352 shows the typical stereographic projection, projected on the plane of symmetry. Figs. 367–358 are the projections of an actual crystal of epidote, here, as a usual, the plane of projection is normal to the present a cone.

200 Forms. The various forms' belonging to this class with their symbols, are given in the few wing thine. As more particularly explained later, an orthodogic includes two faces only, and a pyramia four oily

		Symbour
L	Orthopameend or a-panaeoud	100)
2	Chaopinacoid or b-pinacold ,	7C 101
3	Base or c-pinacoid	(301)
4.	Prisons	h(0)
ξ,	Orthodomes	Mal
-		(614)
6	Canodomes	(Ch2
7	Pyramuls	Mr. P.
	T Atministra	6 <i>kl</i> )

201. Pinacoids. The pinacoids are the orthopinacoid, chimpinacoid

and the base plane.

The orthoping and (100) includes the two faces parall 1 of the plane of life or the same the vertical axis of they have the indices 100 and 100. This firm is do agnosted by the letter of some it is so lated at the extremity of the classes at better or conveniently of the same at better or any amount.

The elemanate of the later of the character and the expert. This have the indices 010 and 010. The character of a congruter by the letter

but is ended the before or beginnered

The base of brase's post of all and then how the translations above and when, partial out of the or be as a holes materile these dot and all the base is be entired by a secret and to often either the state of representation of the secret and the process of the secret and all and the state of the secret and the secret of the secret and the secret of the secret and the secret of the secret of

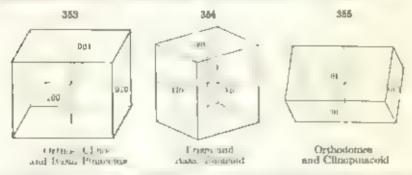
In the melved present frames on these bases papers, a take the property of a few sections of the melberge of the reducer persons are system. It is then produced to there were of technic were in these fear are not considered particle of the control of the contro

202. Prisms. The reserve of the he type the otherwork and prime The root be two so to three closes so follows. As on the many the two solid points of the solid points

<sup>&</sup>quot; had present so it in terms paradon prices and personal config. to

ortherhornlar system, and the explanation on p. 140 will hence make their relation clear. A company eases of these prising are shown in the figures given actor.

203. Orthodomes—The four traces parallel to the cetter axis b, and moreting by other two axes full into two sets of two cacle having the general symbols who are table. These forms are called with stones, they are street y here orthodomes. For example, the unit orthodome, 101) has the faces 101 and 101 tay we do replace—I take intervedues between a 100 and 101 and they would replace be onto edges between a 100 and (101) and they would replace be onto edges between a 100 and (101). These two may are cut forms are shown if getter and both in fig. (55).



Sum arty the faces 201 201 belong to the form (201) and 201, 201 to the

independent but exhipt elements form 2015

204. Canodomes. The charadomes are the forms whose faces are pura el to the incluent axis a, while intersecting the class two axes. It is general symbolizations before 0kl and they are between the base 6001 and the characteristic of 100. The form of 100 and the characteristic faces have for the symbolic, 01. 0.1, c 11 (d). The form of 021 in high 362 is a charadome.

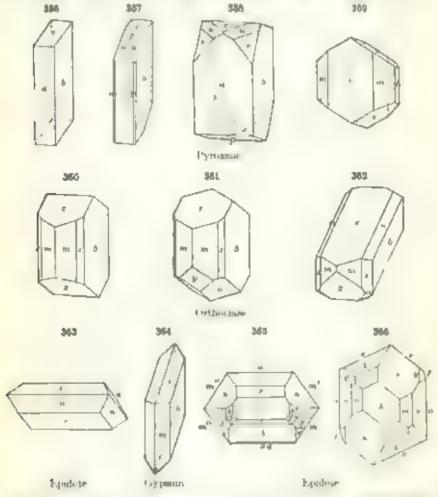
205 Pyramids. The pyramids in he monoclinic system are ad hempyramids, and ricing four faces only in each form, corresponding to the general symbol bill. This is made we found the symmetry, it is shown for explicit in the fact along yet on that the solid ingress of the last prism by 353 see above which are replaced by these pyramids, in into wo sets of careact. Thus my general symbol, is (321) and oles the two dide, endend forms 321 and 32, with the faces.

321, 321, 321, 321 and 321 321, 321 321

The pyramids was also be divided into area choses as and pyramide, that orthogographids bit a when his k corresponds which respectively to the three prisas steads named. Let are at dog as ilso o he in it perfectly, interrupt rathers and bright pyramids of the arthorhor bir system, and the explanation given on p. 141 should serve to take their relations out. But it is in or retriendered that each general symbol encoraces two forms that are like we he four faces each, as above explained.

206. Blustrations. - Figs. 350-359 of pyroxene (a b c = 1092 1 0.580,  $\beta = 74^{\circ} = a(100) \wedge c(001)$ , show typical moduling forms. Fig. 800

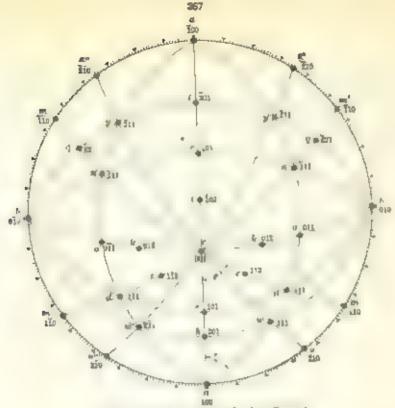
shows the dametral prism. Of the other forms, in is the unit prism (110); p 101) is an orthogone is 111), v(221) is 111) are pyramids, for other figures see p 556. Again, Figs. 360-362 represent common crystals of orthodose a 6 for 0.059, 1 0.555,  $\beta$  = 04°). Here v(130) is a prism,  $x_1(01)$  and y(201) are orthodomes, v(021) is a chinodome. o(111), a pyramid. Since (Fig. 360) c and x happen to make nearly equal tag as with the vertical



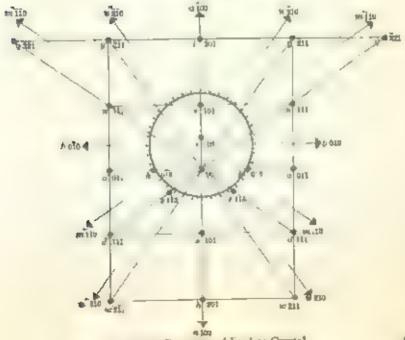
rdge of the prism or, the combination often samulates an ortherhombic

crystal

Fig. 363 shows a monochine crystal, epidote, prismatic in the direction of the m1 -axis. the forms are a(100), a(001) a(101) and a(111). Fig. 304 of gypsum is thetrened 1 b(010); it shows the unit pyramid  $l_1(111)$  with the unit prism m(110).



Stereographic Projection of Equality Crystal

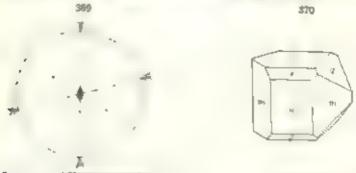


207. Projections. Fig. 363 shows a projection of a crystal of epidote of lag (80) p. 524. In a prince norms, to the principal cross and Fig. 366. It is a smaller crystal to a prince parabole to 5 010. In 1 shows be corrected to 3 and 16 shows the stormarked to 5 010. In 1 shows the care for a 3 and 16 shows the stormarked to 5 010. In 18 shows the same species is go 367. 365. The symmetry of the promisent faces are given in the matter figures.

### 2 HEMIMORPHIC (LASS 29 TARTARIC ACID TYPE

(Spherindal or Digonal Poler (1928)

208. b xl Ax.-2. — The monocume-homomorphic class is connected by a single two fill many symmetry, the crystalographic axis by it is has no plan if symmetry. It is a distracted by the stereographic project on high single apon a plane paratal to 6:010. Fig. 570 shows a common form



Symmetry of Henomorphic Class

Testare Acio

of tarture seed sugar creatus also belong here. The hemimorphic character is distinctly shown in the notification of the catalogues and pyramics corresponding to the the artificial saids belonging bere often extant market pyramics phenomena.

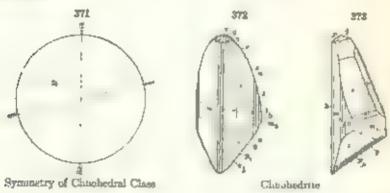
# 3 CLINORIEDRAL CLASS (30 CLINORIEDRITE TYPE

Domatic, Hemshedent, or Planar Class)

209. Let LP — The monochare-characteristic case is characterized by a single plane of symmetry paragraph the characteristic bull of the mass of symmetry. This symmetry is sawn in the stereograph project on made upon a plane parallel to bull of by \$71. In this case, therefore the forms parallel, to the burns, 12 - 00, a 100, and the or boson ending represented by a single face only - the when terms have each two faces in it is to be noted that with the single exception of the characteristic field the faces of a green form are never parallel to each other. The mains given to the transport transport transport transport to the transport transport transport transport transport to the transport transport

Section artificial so to the fig from best there are few known representatives no my materials. The is the rare solution in the archive a conjugate rists, if which is shown in two positions in Figs. 372, 373. As

seen in these figures, the crystals of the group have a beaumorphic aspect with respect to their divel pugat in the direction of the vertical axis, although they can of properly be called hemomorphic since this is not ar axis of as inmoth. The forms shown in Figs. 372, 373, iro as follows, particulable to prisms, m 110, m, 110), h 320 n(120 , t 130), orthodomes, c, fol , s (fa. pyramods, p 111), p, [11], q [11), r,331), v(551), t(771), w(531), v(131), 2, 13.7, y 121.



### MATRIMATICAL RELATIONS OF THE MOROCLINIC STRUME

210. Choice of Axes - it a repeated here Art 1993 that the fired position of the plane of agranders estal when he kneed on a the name of the a aptic or at logical of axes and also of the mans to which as he storm my axes and last estingly as give to the angle of the mans to which as he storm my axes and last estingly as give to the angle of the control of the mans to which as he storm my axes and last estingly as give to the angle of the control of the mans of the control The one I come amover may have aroug actions a the wortness process to meet, one are trace as the processes a 100 upd c 001, and which the dust processes DOTAL OF STREET

212. Attail and Angular Elements. The area elements are the empths of the axes Tank on because of the one toront there, as the analysis will one the a or interest of melitar-

The any dar elements are usually taken as the angle | 00 4 001 white is equal to be angle the new bearings because he torse person as 100, 20, 00 responses, and the set from 10, the new orthodoxes to a 101 and the antellinountee 01. Thus, again for of the case, the negator escaperts are

212 The mathematical relations connecting and and angular elemesterate are given in the four stag caps have so with a, b, and a regressed the saft lengths of the respective crystadographic axes.

$$a = \frac{\tan x - 100}{\pi} = \frac{1100}{\pi}$$
 or  $\tan x (100 + 110) = a = \sin x$  (1)

$$v = \frac{\tan (001 \wedge 011)}{\sin \beta} \quad \text{or} \quad \tan (001 \wedge 011) = c \quad \sin \beta$$

$$c = \frac{a \tan \theta - \cos \phi + \tan \theta + \cos \phi}{a \tan \theta + \cos \phi + \tan \theta + \cos \phi} \text{ or } \tan \theta + \cos \phi + \cot \theta}$$

$$c = \frac{a \tan \theta + \cos \phi + \tan \theta + \cos \phi}{a + \cos \phi + \cot \theta} \text{ or } \tan \phi + \cot \phi}$$

These reintimes may be made more general by writing to the several cases

in 1. Add the 110 and 
$$\frac{k}{k}$$
 after a  $\frac{k}{k}$  to  $\frac{k}{k}$  for  $\frac{k}{k}$ 

Aug

and more generally

Note may that

$$\tan x = x$$
 and  $\tan y = x$ ,

where \$ is the n g = 1 og .56.7 between the some-out ins 001 vill and 001, 110 - also t is too some between in 941 in a sit 111

a his concernment to writing and story the their again in between

213. In president which uses a new acts here are service led using if the gave never each hear give man her a research a to a to a different three means as any me or the to tag of many the area of the comments of (n to ta ' or ta) argum

and a remark and the preceding article removed the anguar and anial elements.

and he are has a more a certain and a more than any are an a color of operations.

In a give the solution of the first are had a great the solution of the property of the supersuper, producted by the first are had a great the solution of the supersuper, producted by the solution of the supersuper, producted by the solution of the supersuper of the solution of the solution of the supersuper of the solution of th Old thing to populate the 190 to 1, 190.

224 Tangert and Cotangent Retail one. The stray is trapped relation has in good for all two section of the pear of the reservoirs. The first two sections are transfer or or process. Ather to The test and the official area to try as fitted generally that

tan (ii) 
$$\frac{1}{1}$$
  $\frac{1}{1}$   $\frac{1}{$ 

Am for the bushiness or tanger to of the anger of the bit of 1021 few 001 are in the This id to the second of the fact that the allege to be the angior of parts agle in the some mentioned, as 121, 111, 212, etc.

For eye our trust theme one notice as from 100 to a his alcount or from 601 to a prison he are greater whereas if man given do Art 54 count for each year. There recent

This of \$1 a.b. to 4 a. chapted, arts, to the proch

There is strong than the ast is copy 000 1 to or 00 1 for 001 213, other if the augher are a new vis. the angles where the are those on a see or to give xound with a received the angle be were 101 app any other face to be given as can to a suited T ......

Let 
$$001 \land 104 = PQ$$
 and  $001 \land 100 = PR_s$   
or \*  $001 \land 111 = PQ$  \*  $001 \land 110 = PR_s$   
or \*  $001 \land 212 = PQ$  \*  $001 \land 210 = PR_s$  etc.

Ther for here of and or that ages, the angle I'v between this and any foresty the group time as the model or said, etc., or a general to the etc., or great the compagnition

<sup>.</sup> The greater opening from which is given who can be been a lie in gley between to y they . They meaning of the manife between may own meet whatever, her as rechiple's ma to be a crate value

For the corresponding some from 001 to \$00, to \$10 to \$20, etc. the expression has the same value, but here

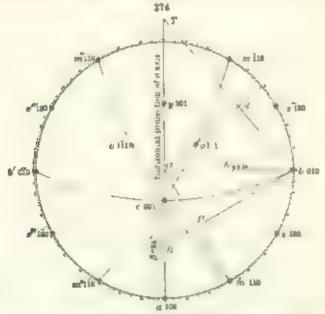
$$PQ = 001 \land 101$$
,  $PR = 001 \land 100$ ,  $PS = 001 \land 60$ , or  $001 \land 101$ ,  $ee$ ,  $001 \land 101$ ,  $ee$ ,  $001 \land 60$ ,  $ee$ 

If, however, 100 is the starting-point, and

$$000 \land 101 = PQ_t$$
  $100 \land 001 = PR_t$  or  $100 \land 111 = PQ_t$   $100 \land 011 = PR_t$  etc.,

then the relation becomes

115. To determine, by plotting, the axial atements of a memorism crystal, given the stereographic projection of its forms. As an example of this good into it to use open that an order than arrangement of the open amounts to the one shows in Fig. 39. Assistent measures) on it can point



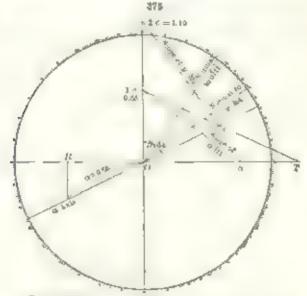
Determination of Axad Plements of Orthoclass from Stereographic Projection

of its faces bested on the storeographic projection. Fig. 374. The magnetism of the axis of the stage die given three of its measuring by near of the storeographic professor the magnetism of the poles of 100 are 100. In the present the three three three form ones not actually occur to be crises and actually occur to be crises and actually occur to be crises and actually occur to the storeographic professor of actual countries of the crises of the storeoff of the storeoff of the crites of the following of the critical crites are the point of the critical crites are the point of the occupant of the critical critical crites are the face of the occupant of the critical crit

the pie to the final. The with between the lengths of the  $\alpha$  and b was an is worldy determined from the position of 1 point the in 1 Draw the  $\alpha$  and line C I from the centar of the  $\alpha$  per form 10. From the end of the b same base a are at right angles 1 if P. The respectite the  $\alpha$  respection of the priors one with the horizontal pulses and the distance C R gives the ansercept of the priors upon the horizontal projection of the a area. The distance C R

therefore is not the unit length of the  $\sigma$  axis but is that instance foreshortened unpowhat here we of the order of a that exist. The parameters by which he true neight of the zone is decayed as shown in high 375. The lane  $R \in S$  if represents this horizontal trace is  $\sigma$  in the a start spin which he distance  $\sigma$  R is thursderrest from Fig. 379. In the parameter of the average, to interest the horizontal trace is decayed the him  $\sigma$ . It is the order of the order that had not a first see a start of the order on the first spin see at the order of the interest of the order of the o

The right of the exercise of them east to the out matter or the p-201 feer. Then there is the east and the query on of the min at eather to, It or be, at The angle between the rotter the projection, (7, Fig. 37), and the way y



Determination of Axial Elements, etc., of Orthoclass

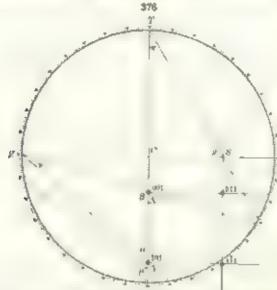
Is necessared by mesha of the electrographic profunctor. From this angle the position of the arm of a section is Fig. 6 to be seen one. The to represent again depend of the fact of the arm that the arm of the section is the fact of the arm that the represent is the country to the regard to the profit in the case to the second to the profit in the case to the second to the profit in the case to the second to the profit in the case to the second to the

the weight on the class can be so a love to be trope the nebration of the permunt to the The method of constraint with the samilar to but leven sed in the proclass who

236. To determine the indicen of a face upon a monochinic crystal, having given the position of its pole spot the sterengesphic pro-ection and the axial elements of the inners. The portion have can rethouse a determine to 1 white the present having the right to public are true to 1 white the present having the right to the public and true to 1 received his start at the face of the department of of the face of the department of the department of the face of the department o

the area. This et also found to be at the nort length and therefore the indices of a rought be

217 To determine, by plotting, the anal elements of a monoclimic crystal, having given the guamonic projection of its forms. The construction by which the profile of will on the personal of the per the case for , vengeter and he goes over tree. The tagle to care old cottary to the night from the counter of the project Straight fine on, a measured Levels by a bound the green season for good scale. Then consider the transfer to T and XYX. The negles a single of the constant to get the constant to the consta s, and a and a are measured. The can post easily be lone by means of the divides carried



Determination of Axial Elements of Pyroseus from Chotman, vinger in a

and the fact that an angle at the prominence was given a measured by one half the pubtonden are. The following relations will then would axed ratio

$$\frac{b}{c} = \frac{\sin x}{\sin x}; \quad \frac{a}{c} = \frac{\sin x}{\sin x}$$

For the prior of these relict that see the explanation of the more general case under the

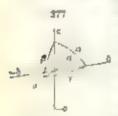
218 To determine, by plothing, the indices of a face on a monocurae crystal, having given the post in of its pole upon the gnomoral projection. The the road of give the given to the state of the given the properties of the given the g than eryotas adressed groups has subject a serve to a statute time probegging

### VI. TRICLINIC SYSTEM

#### Inorthic System!

219. Crystallographic Area. The training system inclinies all the forms which are referred to here used a sub- will all their intersections to he up

When orientated in the castemars guanter are axis has a vertical position and is caused the casts of high 777, a second axis less in the from staback points on page dost, is word the observer, and as



the bases is not the a and bases are so bear that the a axes is the shorter and a axes are so bear that the a axes is the shorter and a axes are to ortherhous a system as axes as a conger and is known as the inverse axis that the second as the inverse axis that the second a to the average between the axes bases, a context of the tween a and a so, and that between a restriction of the axes.

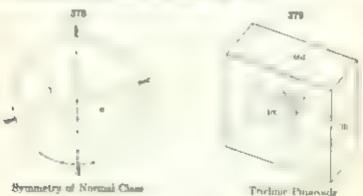
Trickle c Altes

between the values of a start as to the may be generally or thus a determined by the choice of the fundamental torque.

### 1 NORMAL CLASS (31 AVINITE TYPE

Holohedral Penacondal or Central Classes

220. Symmetry C. The permal case of the transport system is characterized by a character favour case the point of intersection of the three axes, but there is no place and no axis of samples is 1) is sampled to shown in the accompanying storeographic projects in Fig. 378;



221. Forms. — Each form of the class metades two faces, parallel to one another and symmetrical with reference to the center of symmetry. This is true as well of the form with the general symmetry are of the special forms, so, for example, the paper result that

Hence, as shown in the facewing table, the four unit prismatte faces include two forms, namely, 110, 110 and 110, 110. The same is true of the domes. Further, any eight extresponding pyramidal faces being to four district forms from y, (1) 1.1 ..., 1.111 11, 111 and sindarly in general.

The arious types of forms are given a fac following bit le-

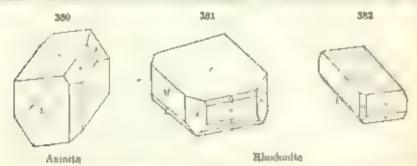
	Eg aja del
Meen pinare I or a pen corl	.00
Brokep ment, response id	(10
Base of e.p. acold	100
Personal	68(1)
	460 4
Macrationes	1914.7
made wheths	411,
District the second	that
Brad's and or	b <sub>1</sub>
	+ 62.2
	(likt)
Pyramics	101.0
	1,6,4

In the many table to see med this to said to construct that to be formational to the formation and the construction of the con

222. The explanations given at her the two preceding existents make it dimensions to because it do all he visions for a laborational exception interference to the cost of cross selecting to their typical to prepare

It may be not true however, out high 379 shows the tremter prism, which as a miscally tree sets of untercharge, its process 1.6. The parties of the cube of the issuation system. Here the rice from subgress in scort ingles it believes a given him, using and argue in differ the proposite to II.

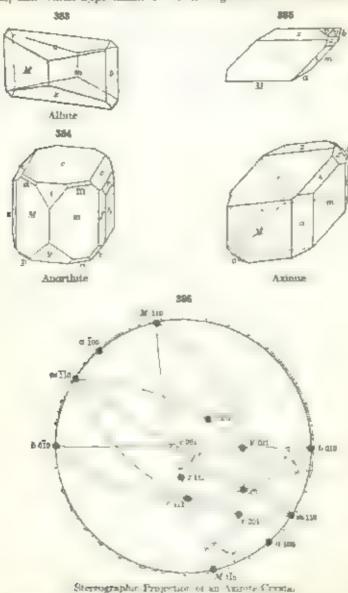
223 Hostrations. A typical traduct ergod be shown in Fig. 380 of against Here agreed in the microperators, merell and My110 the two



unit presents 201 is represented a official result of the sent pyremate. The area of recommendates

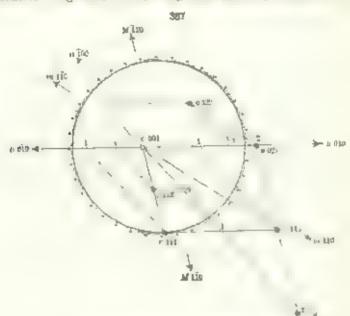
 $a - b - c = 0.19 - 1 - 0.48 - \alpha = 82 - 54 - \beta = .917 - 527, - \gamma = 1.31 - 62$ 

Figs 381 382 show two crys also f rhodomic, a species which is allied to pyroxene, and which approximates to it in angle and habit. Here the faces



nre Presente a 100 r h (10 , 2 00) prisms m 110 , M-170) pyrminds a 221 (4 221 m 2.4) (4.11)

Further illustrations are given by Fig. 383 of albate and Fig. 384 of an reth to fine symbols of the races, besides the pinaco is and the min prisms, are as follows. Fig. 383, xt101). Fig. 384, prisms f,1301, z(130), domes



Guomonic Projection of an Axin to Crystae

#207 , y(201 c(021 , r(001 , u(021) pyranels m 111), o(111), o 111 , po 111 lind g 384 is morthate the san lar v of me rystal to one of orthogone is extern in slight examination (cf. F.gs. 160 life) and candid study with the measurement of at green some that the correspondence is very close. Hence in this case the choice of the fundamental mass is readily made.

1 g 385 represers a crystal of azonte. Figs. 386 util 387 us sterosgruptic and go mone pre-

jectrons.

# 2 ASYMMITRIC CLASS (32) CALCIUM THIOSULPHATE TYPE

(Hominedral or Pedial Class)

224. No Symmetry Begides the normal class of the truth c system duries another possible class possessing symmetry neither with resonance you assume the symmetry of asymmetry of asymmetry

mineral species is known to be included here. This is the most general of all the thirty-two types of one chesified according to hear and my and content and to store, if the classes are arranged in order according to the crystals may show encount of existion. It is the disease title classes which have been described in he proceeding pages.

#### MATHEMATICAL RELATIONS OF THE PRICLING STOTES

225 Chance of Axes. I go a serie from as at high been on I as to the symmetry of the senter but a three land a sent as the rest as the processor, the sent a set of the bear of the ment of parameters of a continue which builting by

- gr 4 /0 1 PM

Were the reading a heard to accept a normation on the other spaces, who here of the one of the sent water which is not the reason to the fact of the control of t ger it id not ger grant etertet in

In their cases where to it is remove the property and where yourd hat it skep if florest , a 4 we Then a sterile in home entirely in this is here a for you to dispute a training the control of the second of the second of the second

23. 3.15

226 Ariai and Angular Elements. The month elements of a tree secretar are the arm of the him to be or a real or a back to make the mater the determinant of five a separatest makes between or your

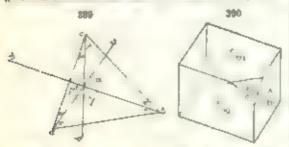
at a name terrents are as a sugar is the output at ween the proper with and in nd and one sea was carte dam I and the a tree topic or acre a are direct june Colone that me

ab. 100 △ 010, ac. 100 △ 001 hc. 010 △ 001 grs. 100 0. 801 ∧ 10<sub>4</sub>, 901 ∧ 011; alm

of incleast, any one or all st these.

Of these an angles mass, one is determined when the there are his own

227 The borner of the annual of water and a great at 1 and religion, the one hand at a be as given with the first a far of a feet of one or a section to great projections and they are perfectly complete and a general trans the residen-



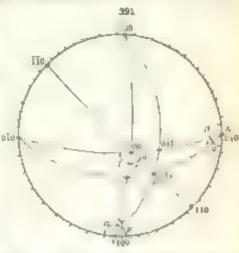
THE STREET STREET the district local to a secretary land and I was an John on glieof he ethine a shaper or the go as well of the great forthe section of the second section of the same pone tet 54 % this a! fren is near to a vigil that they to action get t I it to personal right new to gorn. as tilled to be decreased in water he are dother can got t formula it is to be no sea finit as pertain commission of carrier come to form is truck up pli-

fire perme of these have arready seen explained most the respectance system Art 214.

The firm as good three are of the second to be a like the second three control and the second three control and the second to the second and the second and

Fig. 350 remograps the wests agreeable axis of the tricker removal shadoute. Tilun who have served write at the strongle, but unstance, which has the bundle axes for two

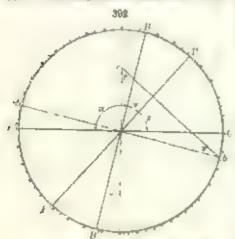
of the water with the city of the state of Inter property to know the beauty to know the age was empress the to the trigg that I ad he would aver for es , it a time is not present to as without we if you be on to a line conserts, to extrame he engit of the d The transfer of the transfer of the length to a best of bean axee or hall win the iring a of the there as the sector as and there are that is dan is her a or a la s mer cast test vice etc. I this are por a se so series de la serie de date I say a K have seen morney tarned as a to progress the ones paint of a the steresors at 100 on the first 301 The new means in great professional series taken pries and the egative as those that's the T a greater as were the error logging the tween the deposit may ones are was the manufacture of the few



the least a sector for generating to carethate the value of these ther angles and from them

do no. the solt of

That he angles shows on the eleccographic properties bug 391 are close on as hathous in high down in his proming the way. Let high Differences on his year of special recording ghi the spiner of a new order of the country was a factor of deep at all operations again to the factor of the factors are a country of the count



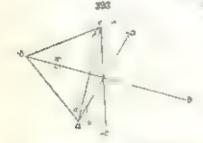
are thoselope to the phone of the figure The asymmetry is follow pasts of to the enter the brown game at the in min place at meht a second to leat axis. The there we let town to the aphere of the appropriate properties to a great of a withinh to the restriction in the morningers " properhaps by 'all to the braned great he it in approximation has be entrue by the inc ( 4 sing at right angles to the distant to the same was all faces mg pura let to the barrs, in the none 100 to 001, would have their cormins to a plant which we are be foreshowness to the time B B The to pro C and B B' on Page 3162 are as tight a give respectively, as the c and beares the cape between here me at equal the size only or I as same to give will appear there are on the steinight of in projection, but "til between the great corden a the two accounts the confinhed are areal of server to that the count to come Finder, be a made to all saces which

in court the hadrone war at their on the gifts with four to a plant a light or gift to the light so of 1 g 1802 as place we let a most of arthographic persons in an tar in 19 On treaters as the present of the Treater action is the or and the contract the formula there are the treaters and the state of the treater of t therefore to the stereographic projection between the corresponding rate circles. In the

same way the identity of the angles T. v. T. S. a ziel a in Figs 780 and 301 can be

With the new section of these angles given the formulas copiered for the calculation in this is a gifter of size of will be angled or, o', o', o', o' and o' are the corresponding under the section of the appeared quantities see Fig. 20.

If the number given are Letween the three parties in the number of the the anti-form's the real time of the second of the second



Thus for the face 321 the fremmes because

$$\frac{\operatorname{PRP}(x_0)}{\operatorname{PRP}(x_0)} \leftarrow \frac{\operatorname{PR}}{\operatorname{ph}} = \frac{2a}{3h} \cdot \frac{\operatorname{ad} n}{\operatorname{ph} \cdot \operatorname{ad}} = \frac{3c}{a} \cdot \frac{4 \cdot t \cdot e}{\operatorname{ph} \cdot \operatorname{ph}} + \frac{2c}{b}$$

It so also to be tested the

where 4 R f are the angles in the paracolous, spheres imagin 100-010-001 at these poles respectively. That is,

$$= \pi \cdot \mu = m + \mu = 180^{\circ} - m,$$
 $1 + r + \mu = n + \mu = 180^{\circ} - n.$ 
 $C = \pi + \mu = m + m = (180^{\circ} - n).$ 

Almo

$$160^{\circ} - A = a^{\circ} + a^{\circ} = a_1^{\circ} + a^{\circ} = a_1$$

Hence having at my by measurement of calculation, the angles between the face on the form of the congression of the congression

These expects are upper when a limit or peak than 90° f their man is greater than 90° the same in the telementation is regard a

229. The following equations are also often useful.

$$\tan \alpha = \frac{2 \sin \rho \sin \rho'}{\sin (\rho - \mu')} = \frac{2 \sin \sigma \sin \pi'}{\sin (\sigma - \tau')},$$

$$\tan \beta = \frac{2 \sin \rho \sin \pi'}{\sin \rho + \mu} = \frac{2 \sin \sigma \sin \pi'}{\sin \rho - \tau'},$$

$$\tan \gamma = \frac{2 \sin \sigma \sin \pi'}{\sin \sigma + \tau'} = \frac{2 \sin \sigma \sin \pi'}{\pi \sin \sigma'},$$

Also,

The calculation, from the legislar descents or from the assumed functions a mass red single, so the color of the angle of present functions face whose symbol of an inchnows face for which measured angles are at hand free for which measured angles are at hand free for which measured angles are at hand free form up of a that is accord to a single one, as the soft for if application time gives as the expectate with the limit of the sign of the sign

230 To determine by protting the small alements of a tricamic crystal, having given the exercising projection of as forms. In other cases, having given the exercising of the

Beg water Properties (4) (4)

1 03 shirter pi njede 20

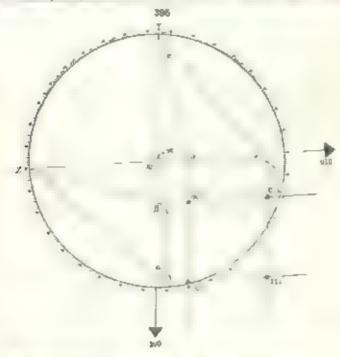
the given a sun he projection. These for all properties for the properties for the project and the project and

the trong a than securior to a band cases were the 600 on the transition see o to the partiength of the e one to reason by a manar way the force of the rank of the ne 231 To determine, by plotting, the indices of a face upon a trium'e crystal, having given the possess of its mie in the stereographic projection and the graph elevante of the material To all cibil probte conposerble is minute face on thoto the a population of the pulation ot the Services in the properties police to a ce (40 and 60010) to be any by appear they recotone of the interestant of the the section of the stand for the the plane of the projection can then he large. plane the gentellarers to a light good I proportions of the and her sha negra dur hare. Signal to the without on the die tip con crist for rejection to 1 tough,

purpose to that for the solutions is some set to attract one to a solute O. The -s for B will represent the foreign a not except of the bare s with the horizon in plane of the pro-

Jection. The intercept two the face will make the text can can can be found by the construction of any.

Let a use Pack above a construction of the can be a can be found by the construction of any and the algebraic and the algebraic and the calculation of a can be a can be



1.0 The intercepts then become 0.71a, in 1.34c. When these are conspared with the analytical distance of the control of the face are found to be

In the states of state of archive the process of a tracinic crystal having given the gromomic projection of a forms. I have been a state of a tracinic crystal having given the gromomic projection of a forms. I have been a state of the stat

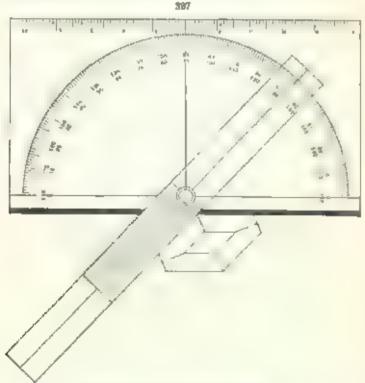
233 To determine by plotting, the indice of the forms of a trickent crystal, having given the past on d other poles upon the gastional projection. The reliable of the silver of the projection of the projection of the projection of the projection of the projection. The

difference has a the fact that the lane of reference open which are plotted, the intercepts of the manufacture to them from the pulse of the faces time of a surject with their five These reference new are cased as the ratio has 0. 10 pp. 101 of the discreption of a subject to the face them are the manufacture of the gradient for A supply of the gradients projection of axistic, bug 385, with almost a chief projection of axistic, bug 385, with almost a chief projection of axistic, bug 385, with almost a chief projection of axistic, bug 385, with almost a chief projection of axistic, bug 385, with almost a chief projection of axistic projection.

### MEASUREMENT OF THE ANGLES OF CRYSTALS

234. Contact-Gomometers. The interfacial angles of crystals are measured by means of instruments which are called gonometers.

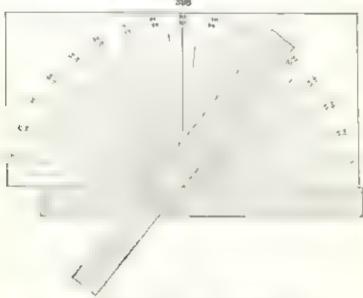
The samplest form is the contact- or hand-gomonister our term of which at represented in Fig. 397



Penfield Contact Commeter, Model B.

This contact-goniometer coversts of a card or which is printed a semicircular are graduated to had degrees at the center of which is finitered a certaint aim which may be thread to any feared position. The mechant time of the general and the goniometer is like-trated in lag 397. The latter of the card and the trackened and of the certained arm are crough to as accurate without no possible with the two crystal faces, the angle between which is desired. Care must be taken to see that the plane of the gonometer is at right angles to the edge of intersection between the two faces. Another modes of the contact-gon meter, hig 308, has two arms swivered togs her and separate from the grainsted are. The crystal angle is obtained by means of the arms and then the angle between their measured by planing them upon the grainsted are. The crystal description as to prevent the use of the former.\*

The satisfies are not well processed, the management entranth to have experted by the management entranth to have experted by



Penfield Contact Contempter, Model A.

sellon we make with a quarter of a degree. In the finest spenimens of crise is when the finest are smooth and appropriate the finest type account and extension of the contract of the finest appropriate contract of the cont

there is re-class rate forms of contact gornous tors have been described but a selectful filter can be used with any give or legree if accuracy than the simple ones described above.

235 Reflecting Contonector — This type of instrument was designed by Wide stein it 1800 — It has and rigorie extensive most range to the type controls in one that here — Only the perfected forms that are in communities today within described.

The principle or deriving the construction of the reflecting generalists will be uncorrected by reference to the figure of ig 300; which represents a

<sup>\*</sup> There says a three deapth of municipal wave decision to S. I. Per and area on to the first three three decisions of the Snethern Science of School of Since I also saty. New Harvey Comportant

section of a crystal, whose nogle, abc between the faces ab, bc, is required. Let the eye be passed at p and the point m oc a source of light. The eye at p, looking at the face of the crystal, bc, will observe a reflected image of m,

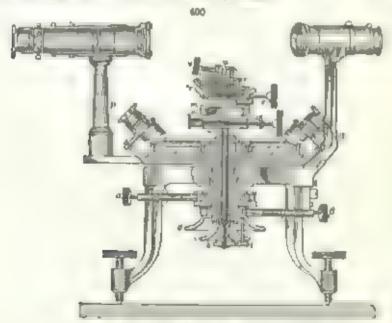
in the breata is of pr.—The crystal may now be so changed in its postion that the same image is sent referred by he next face and in the same treeten, pr. To effect this the crystal must be curred around in I abd has the present direction of be. The angle discussives, bord re, the number of degrees through which he crystal must be truined, it must be incurred by attaching the crystal to a graduated circle when turns with the crystal. This angle is the supplement of the interior angle between the two faces, or in the words at the armae angle between



the two poles one Art 48, p 61. The reflecting gon on cer hence gives

directly the at gle resolution the system of Miller here ( I west

236. Horizontal Computer A form at reflecting genometer well adapted for one to a description as high 100. The particular form of posterioral here figures his made by lives.



Jue-circle Reflection Commenter

The instrument stands on a traped with leveling screws. The rentral rate a has with it a hollow axes, b, with which the paste of turns, carry ag

<sup>\*</sup> The figure here then a from the rannogue is bases.

he tern ery and shouth or every higher way so the upright as prove of which to at me as & W is a second as me as a c who t arrest a gradual ment follows at two attented to the workship of the tangent week, a witness on a to a storm on a lot the most tag to me be It is supposed thong arthrophologic on was fall of band a tight of the tangent ATH THE PERSON OF THE PROPERTY FOR ALSO WILLIAM TO they as he set a series to a good a color of the many colors raffers is a specifical comment that a barrier of the specific contracts at the first to the wall a rate of the first and a weight to the wife a war right sold bear perland har to up to the axis the to say per west 'I has been a supported the continuous statued to a the beautiful and the state of the partition of the parti et at a literal and a soften a property of these two green and to all go for let he see a reas . The signal to escape as no perfect of the tire you must a good be good to import. The crystal or a destina to a complete the second of th a distribute conserved was administrated a great to open a per not as a at the property of the server and morkey to organize a per error of or a seria in the different arridgement consists for at his sections one of him rat wast to higher or other hi to a direct one got the about the design of the greater and to dispressed all are engine of every see become lange to

A country of he surper to the regard various eigeness there exists the rest of the surper to the regard various eigeness there exists the rest of the bear of age to the period of the bear of age to the period of the term of age to the period the rest of age to the period the rest of age to the period the rest of a country age to the period to the end of the age and the age to the a

The netheral see of the content populate breetly as fed one. The other plants a preserved on the crystal to be succusived. The faces of the content of the c

to a position paralle, with the vert is cross take of the telescope. It is notify after of there is a sure and a content of the form of the year of the set of each of the year of the etc. the state to a finite term of the target appropriate gotten as a second gotten Read flow him to a secret or a miller an exist or home him a second to a miller an exist of a second where an exist of a second where an exist or a second or a se The Established Control of the Contr the grant of the property of the control of the property of the property of the control of the c and region a remark for a student a shirter of turn I are the afferent former not an we or letter them.

237 Theodolite-Gomometer A from of gon or eter\* having many the transferred seems as a present to a personal to a personal base was to be a refer to a seem the isternal mentally at the mental means a generalized this week of a the of her as we go no that the or her temports because the true were devised in leptor cartle by hosterous, Cospele and Comparent Copper to all de large twen a secretical space. It is, I so to be an alignation out la en zero a construct by the artificial contage very telescope the action a per I I grade a contra a a a born a b passence in a party of the contract of the time to go \$14 - notes that I do go town a proper port of \$ 100 forms of the carrier process as executed by hard a little course to draw rate the operation fontures of the instrument.

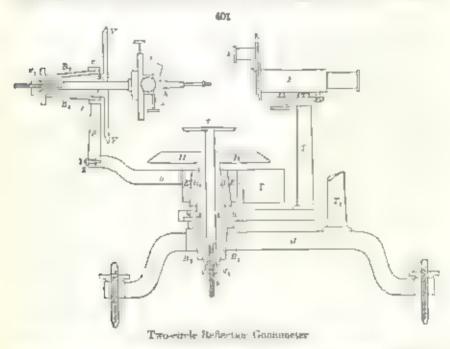
The grantal to be increased in at achief at he and of the axis A. I the your a come and no adjusted I the one find at a water or and righing by the that a good than a chair the pent to the property of the nate and her tenths into the least of the torzon of tree. It using he consequent material faithert's processing the over a night es of the crystal the program of each face is let no need independently of the others by the anequality and if its angular coordinates, or what taght be exhet its lat take and a greater It so posturates are the migrat ward and and tedans that measurest respectively to the vertical and between a core or from an assessment as each triangle ian which are fixed in in at cases at the symmetry fithe erve al. In practire the erve at 18 (Buard's at property) tout the training tope as perpendicular to the yest one caree. A plane a, right at gles to this some - the war prime in the first four a stema in sie on as the polar plane and its position when or necting the agent that the tenescript only notes in the true for the became or tree. The post of a parameter were a the Old plane of the print concest it is less the zero position for the vertical care of for example, with an ere chantic erroral for to promin 1111 in angre of incapancel on

<sup>\*</sup> I religious Transactor Desert of Communication 26 hours 21 574, 1803 22, 230. 1507, 54, 442

the vertical circle) is equal to 010 A 110 and a (measured on the horizontal

circle) is count to 001 A 111.

Gordschmidt has shown that this instrument is directly applicable to the system of indices and methods of calculation and projection identity has which admit the deducing of the elements and symbols of a given crystal with a minorizant of labor and consultation.\* Federical has also shown that this in-



strangent, with the addition of the appliances devised by him, can be most conveniently used in the crystallographic and optical study of crystals.

The following funts as to the mathods of saint this mater part may prove helpful. The telescope and commute have are pussed at some convenent hages to each other formally also at 71. and then a no part a position. The next map is to have the voter position of the horizontal rurle are the part of a which is a rusted name 1 ong at high angles to the axis of the vertical are of wid how the effected beaut of right on to the crossed are of the relessope. They one of the large mater have no because he will take the part of the angle between the excess of his all outer in the energy, the has both the the source of the angle between the excess of his all outer in the energy, the has both the first an interest of the first between the energy of the point has a first point. Then by the mater again as all an end angle of the plane growned to that point. Then by the rung he mater again to the first part and a state of the large of the plane planes has a first of a sub-ringht into the proper position to reflect the eigens of the large of the position of the first position to reflect the eigens of the large of the part position to reflect the eigens of the large of the position.

The given the K gree required by his system for an 2 million 132 pp., Berlin 1807.

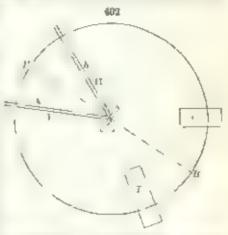
The given the K gree required by his system for an 2 million aperius. Her also Za Krist.

28. Bit 1838. The antise number of these for Kristin furners for the sequence of the forms with group all previous p p binshed crystal figures together with a consequence that observed upon them.

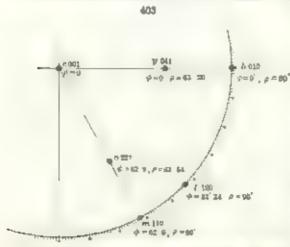
curle is turned through an angle of 180°. This wings the reflecting surface into the position a material to the dotter ties it the figure. In or or to again bring this a rince back to is reflecting position by termal circle will the post hand is moved a the horizontal plane a labe worth. It is tourised. The artificities remanged that position is also noted. The

nage in every last ween these two rescanges as he power post out desired. Then al, when the good h has a the a to tion of the govern has P B a plane normal to the axis would relieft a beam of age, from the commuter acts the telescope. The residue, court at less the sent position of the bur contail circle from which the congres are pressured.

The method used to adjust a cryb as a penthe more cut so dust it will occupy the project passing for nanaurement will vary with he character of the organal A few anatratical cow 1 1) the regital has a ward plane at right angles to a prism con-The expense is the arrived upon the poor A sothat the moss of the protection of as near y as possible paramel to the much of the poet or he bases relater as nearly as was his partial Then the metral and is moved until the reading of the nor restal care e agrees s. It has point position a ready determined Then by means of the frigung scrows I'm erasta is moves duta the reflection from he



bases once is centered upon the cross-bases of the telescope. If the adjustments have been accurately made the agoal will reconsist a ser wide the vert, at or less reviewed Next the horizontal carele is inserted through an argin of 90. This wt. Fring the reflections from the force of the printip some into the telescope. If the printip of the present the vertical time is turned, in difference outside signal from this face falls in the horizon a cross-tain. The reading of the vertice outside and liese on a post of an about the resource. or the mendage from which the a angles are measured. If the present 010 is not present



I in astata possel o to lete tion of theoretical persons from the position of other faces as the prison total or in the core between 01 and 130. 2 It have to no base po no persons a um the crystal but a quart plant one Under here the probables the horizon as control to let easily the let go say act), 90° away from 1 a deterthe mil in late angle at them I ret st at artes of laterial of he spine arrews and he sum a true, he forces of one prior a wall and a the ver ties were bury so the vert of can so a the geommeter is turned 3 16 no thee basel you me man process upone so contrib do that here or this or more has more which we exactly a mires to a theorets as be one plane freto line she error in appear to posse up in the

proper post ion and then able tang reflections for a these faces note that it media inches resulmy preach the Internal right there is no bringer and the ingertion of the age from the polar angle of the I went weak place to come to this position. There we proof the st can try to my to water senter to half I share faces will my men vely subject the signal into the telescope as the vertical circle is turned. The operation may have to be

repeated two or three fines before the final adjust and a totale. If the angle between the me formati the reserve as a sike we the orbition total the sold, the process is a special theory, at order and a sold or total theory per extreme and a diagram or done? These appropriations are not record as a first orbital total or done? These appropriations are recorded to a process of a diagram or done is the real or to per order to be last are orbital or appeared to a special total orbital total orbital orbital

there has a strong on a second which is at the second a special that again a continue of the second second

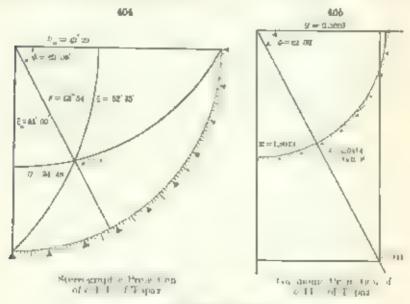
238. Goldschmidt's Tables of Angles (Winkertabellen). Goldschmidt sit in the first size of crystal in castronical role are so windly used that it seems revealed to give an example of the force of angles time be devised register with a real explanation. The material has been taken from an havera logic procede. We keltabellen published as 1897. It is assumed that a crystal of a part possessing the first shown in the hardenful (the of fig. 137. has been assumed on the wo-carde graph effect on basis planate 601 serves as the polar phase and the position of the first time that is determined by the face 5010. Bell were given the angles, etc., or these forms as listed in a typical Goldschmidt table.

					Topas											
				a teth jeho infaç												
q = 0.1385					$a_0 = 0.5540$ $b_0 = 0.953$					ps = 4010 q= = 0.9530						
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y	92	022		h (6,2	.89				.30			E.	311	- 1	DI "	JOY <sup>T</sup>
ő	1	114	uC.	18/163	Park.	25	- (1)	1.1	1/1	"?		-1	18 .	5(199)	.4	2.011
ta .	1	114		4.5	:\$:	4	14		.b7	39	ξ	13)	161 h	4-75->	100	1.51
	1	14.5		* 14	1.5	11	17%	17	154	250	60	15	41	in toll	4 70.	I rulli

<sup>&</sup>quot;talling a seek or or eight of the error is a new as a twice text of Danie Copper and the data on of the born at it is of affective in those given in the tree closers, this of the or a progress about 1 are 188.

Above the table are given after a and cithe axial ratio assumed for topial accuracy that the long a of b equal to the axial ratio with complete a first the symbolic approach to the construction of the formula from the power of the faces upon the vergeometric projection of the transfer from the power of the faces upon the vergeometric projection of the transfer from the power of the faces upon the vergeometric projection of the transfer from the power of the faces upon the vergeometric projection of the vergeometric projection

tred and horizontal lines of reference, in Fig. 405, he z are  $\eta$  of the fuge of 111 equal  $\rho_0$  are  $\rho_0$  of types. In the holds said as significance of he virtues at gles and distances given as in a case in Figs. 404 and 405, where are shown, respectively, one quadrant of the stereographic and gnomente projections of the face  $\sigma(111)$  of topas.

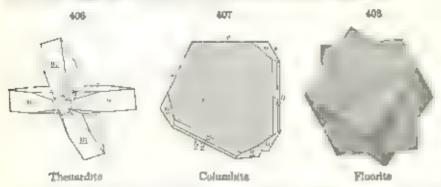


# COMPOUND OR TWIN CRYSTALS

239. Crystal Intergrowths. Crostals common the occur it groups and the incere make composing any group may have curs is relations to each other. In the interests of cases these relations are regular to I depend upon as accidental conditions of showing are for the reasonable conditions of the individual crystals to each other are definite an analysis, to sense law. If an faces, edges etc. of one make the exhibit partial growth a greating For a further discussion of his methal, the regrowth set Art 257. When he we've two inditions of his methal, the regrowth set Art 257. When he we've two inditionals growth age for with only a part of thou sum or faces, edges, etc., in part of positions they are said to force, that crystal or group. The study of the types of amorty-sease sown by different solutions of the saws governing their formal on a no important part of crystallography.

240. Twin Crystals. Twon crystals may be leftered as the atergrowth of two or more and vatuals in such a way ag to year page of such at the case of certain parts of the different individuals, and at the same time other parts of the different in hydroids are in reverse positions in respect to each other. They often appear extern dy to consist of two or to recrysts a symmetric a united, and sometimes have the form of a cross or star. They also exhibit

their twinned structures in the reversed arrangement of part of the faces, in the stree of the writtee, and in reentenar uigles, in certain cases be compound struct release tally be surely detected by an exportant in polarized light. The tipages be as (Figs. 406, 408, are examples of typical kinds of twin crystals, and many others are given on the pages for example.



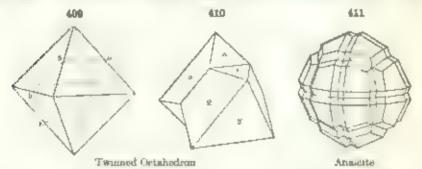
241. Laws of Twinning. In the playority of cases a twin crystal grows as such from the beginning. Exceptions to this relative discussed in Aria 243 and 244. The two or more meny hads compressing a twin crystal base different oriental as of the crystal rotations of the crystal rotations at kinds have certain places or tree the in our most fire rotation is some sample way and it must be possible to derive one orient than from against by set—simple in even not. Learning it mind tropefore, that the formation of will crystals a set—the rest of a small tancous and regular greath according to two it er occupy of the sample monar activers, we may obtain certain geometric a usual of describing

the resultant such a compound growth.

The component parts of a twin crystal are geometrically rested to each other either as if one part was derived from the care by retaining over a place on an or to both or no if one part was derived from the other, you ray olaten of 180° about some crystal and common to tach or as if these two operations occurred similarneously. The plane an axis into ved in the above supposed operations are known as the forming-property and becoming-arts. Suc, twinting planes and axes have in all ordinary cases sur a and national repations to the crystal axes. In rure cases their relations to the great axes may not be get onal, but then they have simple man, is to old axes or makes which me preserve such rut onal characters. No plane that is a symmetry plane in the individual crystal car become a comming-plane in its compound crystal further no axis of even synthety depart, terragonal or hexagona in the advidual crysta, can become a twumang-axis at the compound crystal. It is obvious if such a plane of axis were assumed as twinning-plane or axis the resulting crystal would be recated with the quitwinned individual. On the other hand a symmetry plane or axis of a class of higher symmetry may become a two mag-pt accit axis of a crystal betweene in the stor crystal system but to a class of I wer symmetry Such a twin cryst, must there to assume a sympathy togger than that belonging to its components. Twin crystale of the crystal crisses possessing a center of symmetry will have both a plane of twoming and an axis of twinning normal to the plane. Where a center of symmetry is lacking a twinningplane or sixis may occur independently. These fundamental laws of twinning

are diastrated a the f llowing paragraphs.

Figs. 409 and 410 represent, respectively, a sample octahedron and tatwinned form. The twinning-plane is shown in Fig. 409 by the plane, b 6, indicated by the broken lines, this plane being parallel to a pair of octahedron faces. In Fig. 410 is shown the twinned crystal, the faces of the frist portion, which are marked o, he in positions as if they had been reflected over the twinning-plane, which, therefore, though not a symmetry plane in he simple crystal is one for the twin. The same limit considered as derived by a revolution on the twinning-plane of 180° about an octahedral normal. This direction, which is one of trigonal symmetry in the simple crystal, would



therefore be the twinning-oxis. In this case, the crystal has a center of symmetry and therefore has both a twinning-plane and saxis, normal to each other, the twinning plane is parallel to a common crystal face (11.), and the twinning-axis is a simple crystallographic direction. A twinning-plane is, with rare exceptions, parallel to a possible crystal face on the given species, and assimily one of the more frequent or final amendal forms. Except, as to this rule occur only in the tricinic and monoclinic systems, where the twinting-axis is sometimes and of the oblique crystall graphic axes, and then the plane of twinning round to it is obviously not necessarily a crystall agrapher plane this is conspicuously true in the case of the pericine law of twinning in the plane class foldsoor group, see Art. 256.

Crystais of partz are chart norphous, i.e., either right- or left-handed in their accolorment. Such crystals possess norther planes nor a center of symmetry. It is impossible to derive one type of quartz crystal from the other by any revolution about a (winning-axis, and (win crystals which combine both right and off-handed in in the 4sthere or can possess only a plane of twinning. The Brot in law of twinning in quartz represents the case where the twin position is acrossed by reflection over a twinning plane, name (), the escent order print. (120) but where no twinning-axis exists. Fig. 412A shows a off-handed quartz crystal. Fig. 412C the corresponding right-handed crystal, and Fig. 412B. the corresponding right-handed crystal, and Fig. 412B. the combination of the two into a twinned individual with the plane (1120) indicated by the broken large, as the twinning plane.

Fig. 434 represents a twin crystal of tetrahedrite. It is composed if two

interpene rating tetrihedra with a ordinal to the tetrihedral face common to the two and or hans as twinning-axis. In this case, however there is no plane normal to the twinning exist that could serve as a twinning-plane, is as a plane over which are twin component can be derived from the other by the process of reflection.

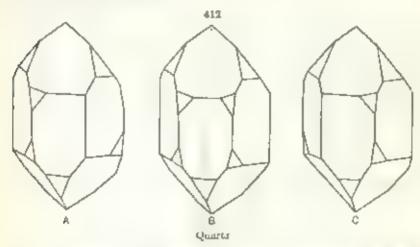
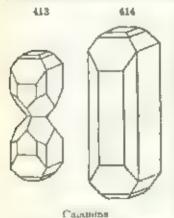


Fig. 413 represents a twin crystal of calumine. Calamine is rite the idea, hemimorphic. The terming-plane here is the himzental plane, the based phages (1984) the apper tial larger hillyes of the twin is ing the reflect as



of each other over this plane. The vertent axis, a rmal to the twinning-place campor be a twinning axis since it is an axis of bit ary symmetry. If the development of the two crystal is such that the prism and pinaconl faces of the two components comerle, thus elin unit ng the cecutrant angles, il e crysta will apparently possess tornal arthorhombic sym-Such a possibility is allown in Fig. 414. where he vertical faces form composite faces , med together along the medial borizontal plane, indicated by the broker lines to the tains, in which, owing to the !wanning, all the fores are present that being to a form of aurain, symmetry are termed supplementary Supplementary twins are also shown it has 433 435, of pyrite, tetrahedrite and Chaylite

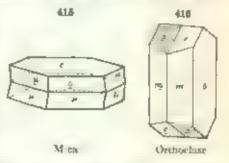
242. Composition-Plane. The plane by which the reversed crystals are united is the composition plane. This and the twinning-plane very commonly coincide, this is true of the simple example of the twinned ortalisation, described in Art. 241 and almost state in Fig. 410. Here the plane also it which the revolution may be conceived to take place (normal to the twinning-axis).

and the plane by which the semi-individuals are united are identical. When not excluding, the two pames are generally at right angles to each other that is, the composition appears to the axis of revolution. The mich furnish a case in which he composition plane of the two crys all is at right angles to the two ring-plane. If gith a presents a mich two the base 001 being the composition plane, the immediate being the theoretical face (11) in tobserved on mich crys also had the twenting-axis being a horizontal direction. Still again, where the cryst is are not regularly developed, and when they interpelied the connect surface may be interrupted, or may be

exceedingly irregular. In such cases the axis and place of twinning have, as always, a definite position, but the composition-plane loses its signifi-

camer

This is quartz twins the interpenetrating parts have often no rectalinear to indary, but mangle in the most stregular manner through, at the mass showing this composite arregularly by abrupt virial no in the character of no surfaces. This progular is ernal structure, found in



metal cheartz crystals, ever the common kinds, is well brought out by means

of powerzed light, also by eveling with nydroth pricacil-

The composition-plant has some men a more letinue signification than the twinning-plant. This is due to the fact that in many cases, whereas the feature is fixed, the twinning axis cand twinning-plant may be exchanged for another and pame at right angles to each, respectively since a revolution about the second axis will also satisfy the conditions of producing the required form. An example of this is furnished by Fig. 416, of orthorouse, the composition-plane is here fixed—namely, parallel to the crystal face of 010). But the axis—free later many be either 1, parallel to the dress and normal to at 100 though the axis—free later may be either 1, parallel to the dress and normal to at 100 though the axis does not concide with the crystal ographic axis. Or 21 he two many-axis may be taken as concoding with the vertical axis and then the plants mad to—s in the graph of face. In other sum therefore, of the possible mutual interchange of the plants of twitting on f composition. In most cases the true twinning plant is evident, since it is purples to some face on the crystal of our put mathematical ratio.

243. An interesting examples of the possible choice between two two ming-axis at right units to said other in furnished by the species stauralize. Fig. the she is a promise to from Forman to two figures at the formal transfer of the same is expensed to the formal transfer of the same interest please to the species to appear but the raise, 130 and 250 formal to two formal transfer of the same interest of the same

to a possible face, and the other does not, and hence there is no doubt as to which in the

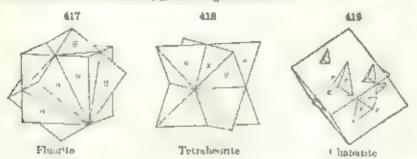
the two anneans

Another attracting case is that furnished by solun late. The common twins of the superior are superior for \$60, p. 190, and have \$600, as the two ning place out twins also occur like Fig. \$60, p. 11 where the twinning-place is 9.033. The we force, \$621 and \$100, are creatly at right angles to each older but the measured angles are in the case. sufficiently exact to prove this, the two kinds cannot be referred to one and the same gav-

244. Contact- and Penetration-Twins. - In contact-turns, when normally formed the two harves are supple commate, being united to each other by the composition-plane they re illustrated by Figs. 407, 4.0, etc. In act and crystals the two parts are seldom symmetrical, as demanded by theory but one may prepondicate to a greater or less extert over the other, in some cases only a small portion of the second individual in the reversed position may exist. Very great irregularities are observed to believe in this respect Moreover the recurrent angles are often obliterated by the abarroad developments of one or other of the parts, and often only an anistinet line on some of the faces marks the division between the two individuals.

Penetration-turns are the se in which two or more complete crystass interpenetrate, as it were crossing prough each other. Normally, the crystals have a conunen certer, which is the center of the amal system for both, practically,

however, as a contact-twins, great pregularities occur.



Examples of twine of this second kind are given in the annexes, figures Plus 408 at 1417 of theorete. Fig. 418 of tetrodosdri e. and F. g. 419 of chapter to Other examples occur in the pages I llowing in for distance. I the species star robte | ga 464 467 , the ecystals of all the sometimes occur in thinge with sprost the perfect symmetry distributed by the ry . It is covering that the distinction between contrat- and pen, rate in turn are not of great motortance and the ine carnot always be clearly drawn between them

245. Paragenetic and Metagenetic Twins. The last nettor of paragenetic and theriageneral two soon as when a soon go that a soon go that the forms are
after at by a not be that it is street a true of the paragenetic true of soon as

In ordered twees the compound structure had to see one is a nuclear compound more ste, or west the de de to be or sings in fathetere camp a treat tim me it come are only treg artist a new to entry of the mark a content to the above the reveral who at first artiple or I afterwine their a sense hange or test in he can define parterior of the extension for the state of the severe of the second severe for the second severe forms how that so twenting a regard or are is here as the get of a train at a he distance mode or map of operation of the letter many + 30 her " De party a houndarined a right of he in he made and him her a cigrature a right and he ends of the crystal are thus bent into one another, and occasionally produce nearly regular prospects forms

The relationate twining is sometimes presented by the successive layers of deposit on in a crystal, as in some party crystals, repectacy amethyst are usequantile dyers, exceed-agily thus, being if a sessie ands. In a sum or manner crystals of the true are for reports, above etc., are often made up of this party.

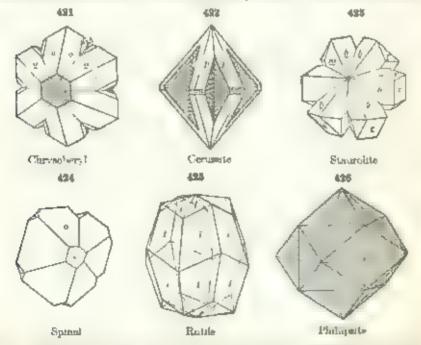
para lel . 6 000 to ow I a pro combination and the face city, accordingly a finally structed parallel to the edge c/h.

246. Repeated Twinning, Polysynthetic and Symmetrical. In the preceding paragraph one case of repeated twinning has been mentioned, that of the feld spare, it is a case of parama repetition or parallel group tag in reverse; position of successive crystalline handle. This kind of twinting is often cauch polysynthe in taining, the lamelle in many cases being extremely thin, and giving rise to a series of parallel lines attractions, on a crystal face or a surface of clearage. The trucking feld-spars show it many cases proyecoth the twinning and not

Ratile

infrequently on both c(001 and b(010), ef p. 193. It is also observed with magnet e Fig 500, pyrotene, barite etc.

Another kind of repeated twinning is distrated by Figs. 421-426, where the successively reversed individuals are no, parallel. In these cases the axes



may, however he in a zone, as the prismatic twins of aragonite, or then may be meaned to each other as in Pag. 423 of stangehite. In A such cases the repetition of the twinning tenus to produce circular forms, when the angle between the two axial systems is an aliquot part of  $360^\circ$  (approximately). It us six-rayed two nest cristian, consisting of three indix, hads been coded to things, occur with chryst tery of ig. 421, or excussive Fig. 422, or stauroute (Fig. 423), since three times the angle of invariance in each case is not far from  $360^\circ$ . Again five-field twins or f charge, over f in the octahedrous of gold and spines. Fig. 424, since  $5\times70^\circ$   $32^\circ=360^\circ$  appara. If glat fold twins or eightnings, of ruple Figs. 425,  $430^\circ$  occur since the angle of the axes in twinned position goes approximately eight times in  $360^\circ$ .

Repeated twinning of the symmetries, type often serves to give the compound crystal an apparent symmetry of ligher grain than that if the sumple individual, and the result is of en speken if us n kind of pseudo-virinetry (Art. 20), of Fig. 457 of aragonate, which represents a based section of a pseudo-lazagonal crystal. Fig. 426 of pt.1 pseudo-lazagonal crystal. Fig. 426 of pt.1 pseudo-lazagonal crystal in a puritiple twan of a monocume crystal may

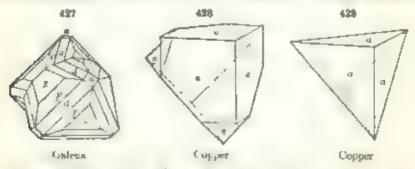
son date as iscinetric erystal, dodecalestron).

Con pound crystais in which twining exists it accordance with two laws at thee are not of common occurrence—an excellent example is afforded by stautolite, Fig. 467. They have also been observed with allow, orthornize, and in other cases.

247. Secondary Twinning. When there is mason to believe that the twinning has been produced subsequently to the original formation of the crystal, or crystaline it as as, if r example its pressure, it is said to be secondary. Thus the cause grains of a crystalline bijections often show such seen thair twinning anisolar. The same are or two made it served in (201) in produced served as a latter page when it is also explained that in certain cases twinning may be produced artificially in a crystal individual—e.g., in calcute, see Art. 287.

# EXAMPLES OF IMPORTANT METHODS OF TWINNING

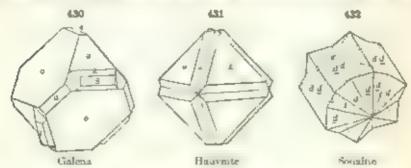
248. Isometric System. With few exceptions the twins of the normal class of this system are of one sind, the twinning-axis an octanedral axis, and



the twinning plane consequently parallel to an octahedral face, in most cases, also, the latter expendes with the composition plane log 410, p. 481,\*

the school and the here as I measure the errors sent to designate the faces so the teamor parts of crystals are listinguished by a surveying too.

shows this kind as applied to the simple octahedron, it is especially common with the spiner group of minerals and is hence called in general a spinel turn. Fig. 427 is now at more complex form. Fig. 428 shows a table twinned by this method, and Fig. 429 represents the same form but shortened in the direction.



of the octahedra, axis, and hence having the anomalous aspect of a triangular pyram d. All these cases are contact twins.

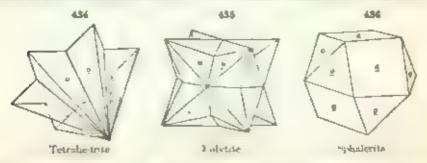
Penerman-twins, from the brisime law are also common. A simple case of theorite is shown in Fig. 417 p. 184. Fig. 430 shows one of galena, Fig. 431 is a repeated between two of happened, and

Fig. 432 a dotterals-iral twin of soga, to

249. In the pyritchedral class of the isometric system penetrate netwins of the type shown in Fig. 4 of are common that form of pyrite is of en caded the root cross. Here a dodecanedral plane serves as the twinning plane and the normal to the state twinning axis. In the case both the plane and axis serve as symmetry enginests in the normal class, and the twinned pyritehedron possesses at the paines of the normal tetrahexated for It is therefore a supplementary twin, of Art. 241



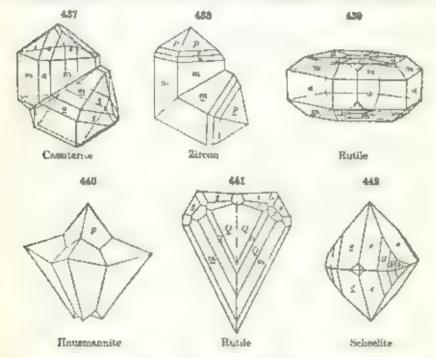
Figs. 434 and 435 show analogous forms with parallel axes for crystals belonging to the termheurid class. The popular development of Fig. 434 of



tetrahedrite is to be noted. Fig. 436 is a twin of the ordinary spired type of another tetrahedras species, sphinerite. with it, complex forms with repeated

twinning are not uncommon and sometimes polysynthetic twin lamella are noted.

250. Tetragonal System. The most common method is that where the twinning-plane is parallel to a face of the pyramid, c(101). It is especially characteristic of the species of the ratio group—viz., ratile and casatiente, also annuarly the saked species zircon—This is allustrated in Fig. 437, and again to Fig. 438. Fig. 439 shows a repeated twin of ratile, the (wroning according to this law, the vertical axes of the successive six individuals he in



a plane (the horizontal plane of the figure), and an inclosed circle is the result Another repeated twin of rutile is shown in Fig. 425, here the successive vertical exes form a tigang line, Fig. 440 shows an anal-

ogous twin of hausmannute.

Another kind of twinning with the twinning-plane parallel to a face of the pyramid (301, as shown in Fig. 441

251. In the pyramidal class of the same system twins of the type of fig. 442 are not rare. Here the basal principal is the twinning-tune, such a crystal may simulate one of the normal class.

In chalce pyrite, of the aparametal class, twinning with a face of the unit sphenoid, p(111), as the twin-

tang-plane is common (Fig. 443). As the angles differ out a small fraction of a degree from those of a regions octahedron, such twins often resemble closely

Chalcopyrise

stanel-twins. The face s(101) may also be a twinning-plane and other rurer types have been noted.

252. Heragonal System. - In the hezogonal division of this system twins are rare. An example is furn shed by pyrzhotite, Fig. 444, where the twinning-

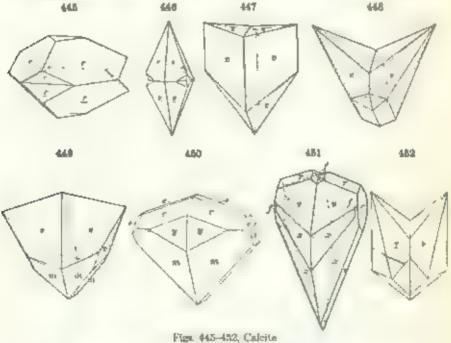
plane is the pyramad 1011, the vertical axes of the indivisual crystals being nearly at right angles to each

other (since NOII  $\wedge$  1011 = 45° 8')

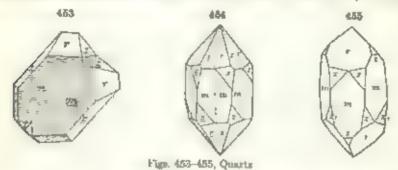
253. In the species belonging to the angenal or thombolicated dayson (whe are estimate. Thus he twinning-axis many be the vertical axis as in the contact twine of Figs. 445 and 446, or the penetral on twin of fig. 419. Or the twinning-mane may be the unituse the inhonedron a 0112,, as in Fig. 447, the vertiend axes crossing at angles of 1274" and 524"



the twinning-plane may be refull? as in Figs. 448, 451 the vertical axes nearly at right angles (90%) or (0221), as in Fig. 452, the uses inclined 531" and 126!"

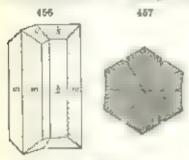


In the trapezohedral class, the species quartz shows several methods of twinning. In Fig. 453 the twinning-plane is the pyrapid (1122), the axes crossing at angles of \$44° and 954. In Fig. 454 the twinning-axis is a the axes hence paraged the maker hais both right- or both left-handed but unsummer real r(1011) then paralel to and conveding with a 011.) The resulting forms, as in Fig. 454, are mostly properties twins, and the parts are often very irregularly united as shown by dull areas (z) on the plus rhombunetim face of the rwise these twins are recognized by puroelectrical philosomera. In Fig. 455 the twine of plane is not 20 — the Benzu law the manyidulus respectively rights and left-handed and the twin symmetrics.



with reference to an a lace, these are out to aregular popularion-tweek in these twins of the ship with a recording polarized light the phenomenand Arry appeals. It may be adjust that present with a figure of critical of the strategy of criticals which there by confirm to some more or oss complex twirm of the but where the greening a nevertheless only repolar til

254. Orthorhombic System. In the orthorhom as system the comprincist in their of win ing is that where the twitting-plane a face for



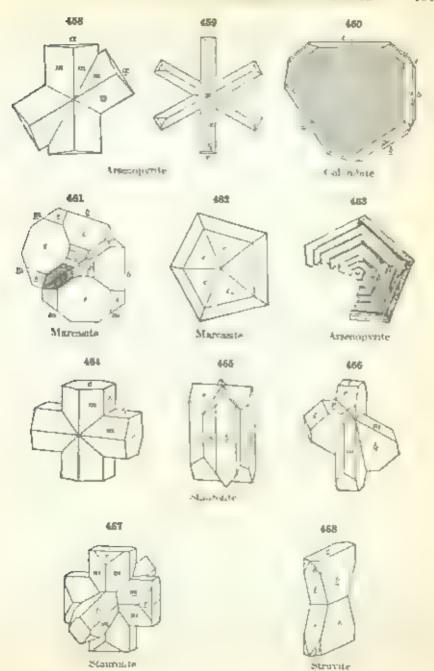
Fragonise

prism with the prism of gle of get for me ray for. This is well above, with its species of his arrager to group. In according with the prior per strong in Arr. 246, the with the prior per strong in Arr. 246, the with me forms of a pseudo-frequence of the forms of a pseudo-frequence of a region to the first resemble a like a few was a top of the arragement prism revenue of twinted character by the structures of the basis, plane at the regular ties of presemposite prism forms due to the first character is the top of the the prism after again to the exactly (ii). With

till or tree and propelite apparent has good on create are even on, but the tree and pass twintary is reversed in polyrized light, as moved here. Such twins which suit if the even color of mother and he resymmetrical crystal system are effect called access to easy.

Farrang of the same type of where a dome of 60° is twarring-plane, so come is said arome pyrate was a 101 it is allowed in Figs 458, 459 also by 400 of colorate a but compare hig 197 at bremarks in Ar. 243. Another every as given in high 421 of alexandrite chryspoery. Clives be, autographe, have a contract appears with which this kind of (winning is common.)

Another common josthod of two many is that where the twinning as parallel



to a face of a prism with a prism angle of about 70)°, as shown in Fig. 461. With this method symmetrical fivelings not infrequently occur (Figs. 462, 463).

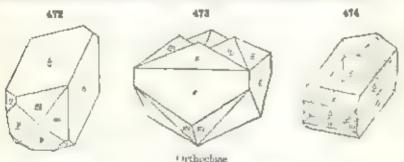
The species staurable i listrates three air is of twitning. In Fig. 464 the twinning plane is 032, and since 001 1032 = 45° 11′, the crystals cross hearly at right sugges. In Fig. 465 for twinning-plane is the prism 230; In Fig. 466 it is the personal 232), the crystals then crossing at angles of about 60° stellate trillings occur (see Fig. 425) and 0 deed more complex forms. In Fig. 467 there is twinning according to both 032, and 0232.

In the newimorphic cass, twins of the type shown in Fig. 408, with c(001,

ne the twinning-plane, are to be noted.

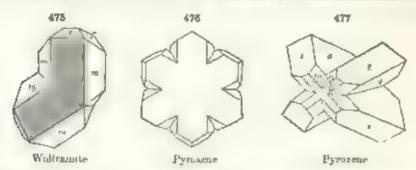


255. Monoclinic System. — In the monoclinic system, twins with the variet call axis as twinning-axis are dominon (see also Art 242). This is illustrated by Fig. 400 of angule pyroxene). Fig. 470 of gypsum, and Fig. 471 of orthocore see also Fig. 410, p. 183. With the latter species nese twins are called Carlishad terms because common in the interruption of Carlishad Bohemia), they may be contact-twins (Fig. 416), or irregular penetration-twins. Fig. 471. In Fig. 416 it is to be puted that c and x fall nearly to the same plane.

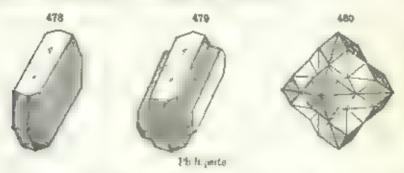


In Fig. 172 also of orthoclase, the winning-plane is the condome (1921), and since (1991 \lambda 021) = 44° 56° this me had of twinning years morely square pressure. These twins are as od Barcon facus (from a prominent locant). These twins are as od Barcon facus (from a prominent locant). These twins are often repeated Fig. 473. In Fig. 474 a Manchae's facus is shown, here the twinning-plane is <,0011. Other repeated types of twining plane is shown, here the twinning-plane is constant with pyroxene (cf. Fig. 487, p. 195).

Twins of the aragonite-chrysohervi type are not ancommon with monoclinic species, having a prominent 60° prism (or dome), as in Fig. 475. Stellate twins after this law are common with chondred to and chrohumite. An analogous twin of pyroxene is shown in Fig. 476, here the pyramid (122, is the twinning-phane, and since f010 \* 122 = 59° 21′, the crystals cross at angles of nearly 60°, further, the orthopiascoids fan nearly in a common zone, since

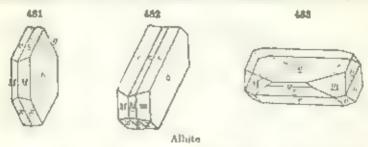


(100  $\wedge$  122) = 90° 9′ In Fig. 477 the twinning-plane is the orthodome (101). Pholipert and harmotome exhibit must ple twinning and the crystals often show pseudo-symmetry. Fig. 478 shows a cruciform fearing with c001, as twinning-plane, the twinning shown by the structure in the side face. This is compounded in Fig. 470 with twinning-plane. 0.15, making nearly scalare prisms, and this further repeated with  $m_{\star}$ 15) as twinning-plane yields the form in Fig. 480 or even Fig. 426 p. 155, resembling an isometric dodecahedron, each face showing a fourfold striction.



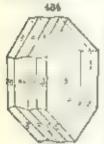
266. Tricking System. The most interesting twens of the tricking system are those shown by the femapers. Twining with 1900 as the twinting-partie is very echnicis, especially polysynthesis (woming yielding this parallel camella, shown by the stricking on the face ever the corresponding converge surface) and make charp reynded it polyrical again. Then is known in the allate law fags, 481, 482. Another important a sthool of given as that of the psychology that, the twinning axis is the crystallographic axis h. Here the twins are all ten by a section, chapter section, shown in the figure and further explained under the telespace. Polysylv ballic animaling

after this law is common and bence a cleavage-mass may show two sets of s right was one on the surface parabolity of \$1001, and the other on that parallel to



The angle made by these get strictions with the edge 001/010 is

characters at of the particular true has species, as noted later.



Twins of a bile of other poor types also occur, and further some an dar to the Carlshad, Bayeno and Manebuch twips of of source is glast an wat with hig accordmy to both the acute and Carlsbad types.

#### REGULAR GROUPING OF CRYSTALS

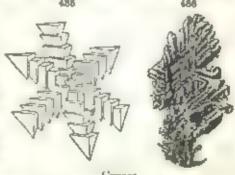
257. Parallel Grouping Connected with the subject of this cresisters that of the parallel present of associated crys a sid the same species, or of different species.

Crystag of the same species occurring together are very comes he in paralle measure to the are large crystain. as of calette querie, if onte, are somewhere built up of

strate print duals grouped toge her with retresponding faces partled parala, grouping is often seen in crystals is they be on the supporting rock. On glansing ever a sure or covered with crystals a reflection from one

face whofen be secomposed by reflections from the curn an a ling face in each of the other crystale, showing that the crystals are tarraghout similar in their poei-Moras.

With many species, complex crystalian forms result from he growth f parallel partial crystale in te direction of the crys adographic exes, or axes of symmetry I as deadrine forms, resembling branching vegetation, often of great designey, are seen with good copper, argentite, and other species.



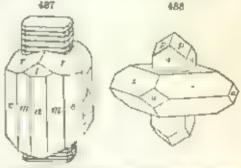
Compar

especially these of the isometric system. This is shown in Fig. 485 (ideal), and sgun in Fig. 486, were the two med and flattened cubes (cf. Fig. 429, p. 186, are grouped in directions corresponding to the diagonals of an octahedral (nee.

258. Partial Parallel Grouping f the Same or Different Species. - Crystale of lifferent species often show the samp top letery a partifology or materal position. This is true most frequently fisheres which are properties chosen sometiment form and composition. They will show a paralle less trop between certa to usus a sarabor primes in the two spaces, or the parallelism of cora in directions. Such groupings of unlike species road he has to close situearnes in crystal structure that control by runtial order at on of their The areverne purpose of the two remorals that are in on see with each other probably have afterne arrangements at some as of shirts aleptical character. I rescals of oute, implanted on survice of orthogone, are sometimes no example of this, cristals of ai philode and pyroxene

(Fig. 487), of zircon and zenotime (Fig. 488), of various kinds of muca, are also at times observed assomated in parallel position.

The same relation of position also occasionally occurs where there is no connection in compogition, as the grysteis of rutile on tabular crystals of hematide, the vertical axes of the former comciding with the horizontal axes of the latter. Crystals of calcute have been charryed at sections be bedrad faces had a series of quar a crystals upon the r, all Amphibele carosing in peradel position, some thes pyrocers in parties three such quartz crystals, one on



Versitable en-H your resignation offi-

each shou be redea face entrees envelop the calcute, and unite with treater my mights to form peculosis us potential ago of pungty after cause. Pur design without the spheroidal chalconyrite upon to ctransara setalor a six common, the similarity in crysta structure of the two species controlling be position of the crystals of chalcopyrite. Cases 7 to been described of a titler grauping of the crivitais of the same substance in which a certain plane or directly to is common to the sufferent individuals but which the order pary laws of twinning wal not explain.

# IRREGULARITIES OF CRYSTALS

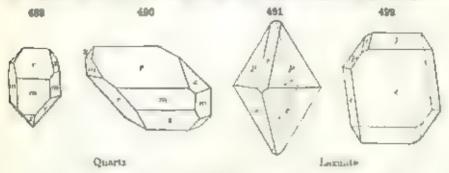
259. The laws of ergatallization, when namodified by extrastic enuses. should produce forms of exact geometrical symmetry meter by the angles betrig equal, but also the horner good force of crystan at 1 the dimensions in the threations of like axes. This symmetry is however so incommen that it can hardy be considered other than an ideal perfection. The various possible kin le of symmetry, and the relation of this idea, geometrical symmetry to the netual crystallographic symmetry have been decused in Arts 14 and 18 & seq. Crystas are very generally distorted, and often the fun lamental forms are ac compately degreed that an inter ste community with the possible arregs, arities is required in order to unravel their compactities. Even the angles may occasionally yary rather widely

The regularities of ervains may be treated under several heads. I Variations of form and armousius x. 2. Imperiections of maface, 3, Variations of angles. 4, Internal imperfections and impurities.

# I VARIATIONS IN THE FORMS AND DIMENSIONS OF CRYSTALS

260. Distortion in General — The variations in the forms of crystals or in other words their distortion may be error due to character terian faces some bugger and of new smoother than in the mass generate as soud. On the other hand of may be symmetrical ground to the distorted form the symmetry of a group or system. I florent from that to which it act is, a belongs. The formet case is the condition rule, but if a latter is the more interesting.

261, Irregular Distortion. As stated above and on p 13 oil crystals show to a greater or less extent an irregular or accelerate ariston from the ideal geometrical form. This distortion, if not necompanied by equage in



the interfacial angles has no particular significance, and does not involve any deviation from the laws of crystallographic symmetry. Figs. 489, 490 show that sted crystals of quartz, they may be compared with the lifed from Fig. 303, p. 130. Fig. 491 is an ideal and Fig. 492 an actual crystal of lazu, te.

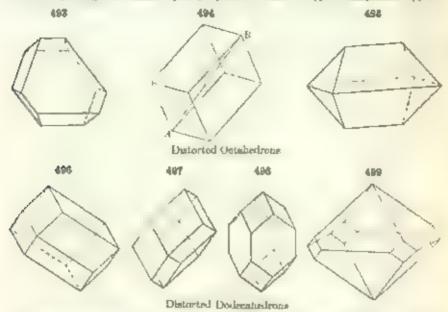
The correct transferances of the forms on a crustal is rendered truck more of the literature of the present of the forms on a crustal is rendered truck more of the state of t

In addition to the variations in form which have just been described, still greater are guizantes are the to the fact that it many cases erverals in instance are attached either to other crystals or to some rock a rince and in consequence of the are only partially developed. Thus quarte crystals are generals attached by one extractly of the prism, and acree may only one selectly farmed crystals, baying both ends complete are tore.

262. Symmetrical Distortion. The most in creating many per of the symmetrical distortion of crystal the forms are found unto g crystals of the mannetime system. An elongation in the direction of the carrie may give

the appearance of tetragonal symmetry, or that in the direction of two cubic axes of orthorhood symmetry, while in the direction of an octane-draft axis a lengthening or stortening gives rise to forms of apparent rhombolicalral symmetry Such cases are common with mative gold, aliver, and copper

A cube lengthened or abortened along one are becomes a right square prints, and if Yarred in the direction of two axes is his post to a rectange at prime. Cubes of minte. garcine, flaurite, etc., are often than distorted. It is very incours to find a cubic ervical the is a true symmetrical cabe. In some species the cabe in whaterion or other sometric form, is lengthened into a emillary crystal in needle, as happens in capitle and partie



An orthhedron floitened parallel to a face - that is, in the direction of a tengonal eye metry axis to respect to a talk are created removed by a rhost technical cryatal with to all young high 49th . If was the read in the same corner is a change and I B high 40%, to the of erest m of the term, n, or everter own, it because no more than which in.

When it outsidedrous extension to the own and if a local warm to appear to algorithm.

or the distance, symmetry area, it has the general form of a recongular constant or and sto Carthur extended, us in Fig. 195, it resembles a communation of two orthorhomine day es

min of the crite, a agree is c

The time for a bourthoned in the carection of a tragonal symmetry axis becomes a winds the prome with these-angled minimized, as . Fig. 400. If so otherwise to the same time it see since a short price of the same kind box 197. Both researche required rail I to search a remaining a paraet. When langularing in the direct is at one of the color axes. I whole hedror becomes a square priors with pyra- and as not to us 1 by and at ordered along the same axis it is reduced to a square octaloximit, with truspenced angles (top 4:6)

The trapetobodom obragated in the direction of an octahedral trigional) axis assumes

the sweemal tracts ayon etry

of a substitute of the capita theoretic takes inforce mong a callar axis, it becomes a double eight soled for and with our inforce with a latest contribution to be a finished with our inforce with a latest contribution. a arriver at air of becomes a re in not eight safe; but he pyrams. The trace taked or totals and safe or the trace taked or totals and serior are thereon abovers may also distortion

of the assess and. It either emmission are to be found as the other systems.

# 2 IMPERFECTIONS OF THE SURFACES OF CRYSTALS

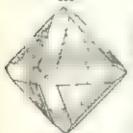
263 Strictions Due to Oscillatory Combinations. - The variable lines or Cirrows on the surface a crystal are about structure about such such entriaces are said to be structed

but the religious and the surface a measured by two narrow planes the region of the region of the property of the president of the region types of a rest is not fit so a gos have been a round by a contract once-I so the other two of the case is good party and it and it interbit of a total saget from Br. de at the at printing of a printing ore marked a partial base with a secrees and agrees places meeting a all the filests ititing here go referred to

fine a utar a on distinct place, it form signif spring his large correct a testing on to grow the lawrent of street and on our trace ery tale of quartar on the approximation to the property dependent on has take place between to proceed and though side, frees. Thus trial actionists are but mention point will not tonge alternate ma-

(titler (), y is in the front on the pulse faces of participarille to the presentance of a color with the times of the period size of the were as at magnet to be a becase to an between the net between at I Pristing of the time on the contract the state of the of or semenated 600

to been been such as no six to a mercation combut here if he was a the promise every



Magnet te

264 Striations Due to Repeated Twinning are as I is besilplined abute and ther trie feel atte, so of the remain traffic are new of service that were a mile in her 246 as her to the a more financing. This is the false by by an of a agor a from Port Herry Na York (Kemp.)

265 Markings from Erosion and Other Causes. The fire a residence often they to have La cry t | to wir , tore | level appel as . A comprehen of it hag by some about all goes to the govern

grafing a strain see they a don't had like any on their eather to compare the second or present a extent or well regard to be rape to see more traper exendence in sign of parts, ene sequences your than to reach of that well type over the settlement of or the statem, stage in a prime a toping to a faul remain in severe make Interesting it is take that her rich his correspondings on to stop it and enter off registing in a star of the at a 1 778the way that oped in the cars of and the of etching will a mean seal, with late place many are now Art 201;

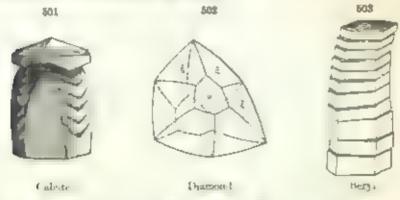
The strange on the extract of the extract of a special however shows to be part to be I big it the coast of opposition to the first of the first of the first operation in the first operation in the first operation of the first operation operation of the first operation operation operation operation operation operation operati the example of force for the form of an partitude source to the end to precess and a great or the contract of the property of the present of the property of the present of the pre from serve to him the sime of the patient. They have a hoper f catenag from all in tray (s, or ) prima levelopable to a form the particular and arelation of a tres being the result of completed are at tree from their thing chapes. It's in, es of the markings marged to

occur on the crystals of most minerals, and conspicuously so on the rhombo-

hedral faces of quarta.

Free- of crystals are often marked with angular elevations were or less that not which are due to use had are confined to the defect of min to called processing from an oscillation between the less and at the processing from an oscillation between the less and at the processing from an oscillation between the less that the general processing from an oscillation between the less that the processing from an oscillation between the less than the processing from the option of each a creat debtween the less passers at all a timer sum are cases could be mentioned.

Whatever their cause it eseminate mark against from of great importance as revealing the trace in sect of symmetry of the cross of the first in a few from the symmetry of tryst had the faces to be the place in a back of that s, in regard to their same character of this for happens that on all the crystals of a species from a government, it perhaps from a scalable, the same places are crossed in respect to the faces of market crystals in this respect



266. Curved surfaces may result from a) oscillatory combination; or b) some independent nelection on their producing curvatures in the lamber of the cross as or or other atent at a const

I reced surfaces of the test kern out were are as importanted Art. 263... A single for market or of this continues seen in fig. 501 of extense in the lower part traces of a second ober rule or one apparent which was in assistantory cannot be a second or a second ober rule or one apparent which was in assistantory cannot be a second or of the continues of a second or rule or one apparent which was in assistantory cannot be a second or of the continues of the con

Unation with the prismatic form.

Curvatures file second kind some the base of the faces convex. The utilic case there is a fact of fig. 2. I ame of when residence upheres. The made of curvature in which ill the faces are eq., it convex is assection a thin that in which a center is a race of present and periode to a corresponding or occurs against this curve. The rest case curves of freeton windows and he hadging scenario at payerness is not near are other examples. The alabase restress from the Matanith Case Kentucky, are so far. Submite crystals so it made to be provided to the state of th

A third kir I of curvature is of management organ. Sometimes creatals appear as if they had been broken a taversely of a may precess, a alight displacement of which has given a curved form of de prism. This is common

in tourmakine and beryl. The beryls of Mouroe, Connecticut, often present

these interrupted curvatures as represented in Fig. 503.

trystals not infrequently occur with a deep pyr and lat depression occupying the place of each plane, as is often observed in common salt, and, and supplier. This is due in part to their rapid grow b

# 3. VARIATIONS IN THE ANGLES OF CRYSTALS

267. The greater part of the distortions described in Aria 281, 262 occasion a change in the interfacial angles of crossids. But these imperfections that produce convex, curved or strotted faces necessarily cause such variations. It arthermore circ instances of heat or pressure under which the crystals were finited may some most have resulted not only in assortion of ferm, it is assorted to the time of crystals and not our attention of the present of importance at the time of crystals as on may also have a fixe offers.

St I more important as the datage at the angles of completed executed which is caused by subsequent pressure on an matrix in which they were formed as, for example the change which may take place during a more continued as, for example the change which may take place during a more continued.

less complete motors of bont of the new surg rock

The hange of compass, is radius gon use longerlous ervetule see Art 278 is generally accompanied by an irrogener change of angle, so that

the pecution orphs of a species view mach in legg-

In general it is safe to affern that, with the excepts a of the irregularities one ing from importer that is the process of crastic sector, or from the subsequent changes, unterlate, variance a in angles are rare, and he constrainty of angles and of the late of the late of angles and of the late of the la

It cases where a greater or was versa, it is a signist observed in the crystals of the same spicies from different locantees, he cause for the care on the local found of a difference of chemical companion. In the case of tachorphia a compound is a set I known that an example of corresponding error of your threshold a smart take place with a short greater than a smart take place with a short greater angles.

The officer of next upon the form of crystas as atailed our Art 445

# 4 INTERNAL IMPERIFCTIONS AND INCLUSIONS

268. The transparency of creaths a often his word by distinted creatile fixition by impriring taken up from the addition being the process of creathing to or, again, by the process of theigh matter resulting roup partial claim and a remained. The general name in cases is given to any foreign basis me seed within the creatile, additional face on tools are extrainely count on, they may at green is left at our other, visible to the

una ded eye or requiring the use of the pay how per

Rapid crystall auton is a company explanation of reliasons. This is illustrated by quartz crystals continuing arge as these follow there will of water (in the latter case these slowing a novable bubble or, they may contain said or is a exist to large an out. In the case of case as, crystal and the from a part singlet charges, with a foreign material acquartz said may result in the formation of crystals in which the impactly makes up as ritch as two thirds of the whole mass has a seen in the furrous bondance much mestone, and arm larly in that from other conditions.

269. Liquid and Gas Inclusions, — Attention was early called by Brewster to the presence of fluids in cavities in certain minerals, as quartz, topar, bery, chrysolite etc.—In later years this subject has been thoroughly studied by Soctov, Zirkel, V go sang lessoner, flosenbasch, and others. The nature of the rape of the case of CO<sub>2</sub>), or by chemical certain attent. In the majority of cases the observed lapact a surply water but it may be the salt solution in which the crystal was formed, and not infrequently, especially in the case of quarts, liquid carbon rough of O<sub>12</sub>, as first preved by Vogelsang. These hand inclusions are marked as such in many cases by the presence in the cavity of a movable

britche f gas the assonably eachtes contain two hourds as water and liquid earbon thousand, that I iter then incoming a bubble of the same substance as gas of lig. 504. Interesting experiments can be made with sections showing such iterative p. 203. The maxime of gases yielded by smoky quarts, meteoric ron, and other substances, on the apparatum of heat, has been an-

alveed by Wright

In some cases the cavities appear to be empty, if they then have a regular form determined by the crystalization of the spaces, they are often called negative crystals. Such cavities are commonly of secondary origin, as remarked or a later many

Berylorate

270. Solid Inclusions. The solid in minors are almost inflate in heat variety. Some lines they are sarge and distinct, and can be referred to known on real spaces as the scales of greenite or herautic to which the peculiar character of avent into feedspar is due. Magnetite is a very common orparity in intoly increased appearing, for example, in the Pennsbury mica, quartz is also often incclaimably mixed as in stand lite and guidhoite. In the other hand, quartz eristals very commonly inclose foreign material, such as of lerite, tourns the ruble homeiste, assestos, and many other americas (Cf. also Ar s. 271, 272).

The inclusions may consist of a heterogeneous mass of material, as the grantic matter seen in orthockies crystals in a perpayrite grants, or the febispar, quarts sets, sometimes inclosed in large coarse crystals of beryl or

spedumene, occurring in grante veins

271. Microlites, Crystalites. The enteroscopic crystals observed as median as may sometimes be referred to known species, but more generally their true nature is a midful. The term microbies, proposed by Voge sing, is often used to designate the minute inclosed crystals, they are generally of needleake form, sometimes made irrigular, and often very remarkable in their arrangement and groupings, some of them are exhibited in Fig. 510 and Fig. 511, as explained below. Where the nature individuals belong to known species they are collect, for example, feldspar microlites, etc.

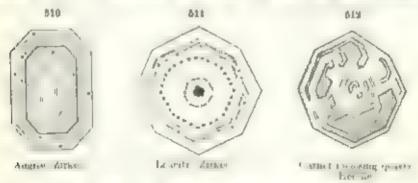
Crystastites is an unalogous form used by Vogelsang to cover those inmute forms which have not the regular extensiviform of crystals. But may be considered as intermediate between amorphous matter and true crystals. Some of the forms are shown in Figs. 505-509, they are often observed in glassy volume rocks, and also in furnace-slage. A sense of names has been given to

various of crystallites, such as globulates, margarites, etc. Trichite and to confidence manners of troth and by Zirker, the former trains is errors from the former trains is errors from the former trains in errors from the fact in Fig. 500, are common in one disc.



The new member of classes a may also be of no arrogs or guessy in tage, than a second consistency or a cryst is which a second from a new centiless, as lava or the dag of an iron furnish.

272 Symmetrically Arranged Inclusions.— It general which to sold used the service of the experience of



and applicate merchs and his fill shows arest had one on aporton whose cryst a very corn and monose foreign a steer 1 g 51, shown a section of rarys a figure of the mag q = 2.



At the straint ground is filterled by at because 1 g 510, in which is it has come as one in the size of color or did inventional remarkably arranged so as to just symmetrical figures of our as forms. Stauroute

recommendia shows analogous carbonageous unturities at innetreally disredainted.

The progretate community as an inclusion in museovite, allo led to obeye, is always symmetries y disposed uson y partiel to the directoris of the percussion-figure (Fig. 517, p. 211). The ascender of

phogens e a captured by the presence of symmetrically armunged of them to of Art 375;

Fig. \$14 above to interest top case if a varieties alls are e-god to more I term all term in the right of the property tion of the last has been to be to the total the total to the sale district of sizes is intergeneers for a few orthogoners he to come and the property of the angles At a present and the art of the second by government to so all the manufactures and the second property of the sec has not yet been identified except a fire was



Encryptide in Allute

#### Letter contra

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Brewster. Many appears, jar dispert or with its littless dural Magnane, and the ful toga Phil Jorna 1925, Sa

Burr, Loonhard, Seyfort, A Sacheng The harm one was Maneralist to at a n street Mineralies. Haarlem, 1854. I see re-

Sorby to the epocopies struct to decision to Q J to Soc , 14, in 18 h. ATT A THE PERSON NAMED IN

Sorby . Bu er in the armet re of ra es eq have necessary, and name other minerala, Proc. Roy Boo., No. 100, 1000
Re sch. L. brad rev. Progr. V. 120 ct. 18
Vogetsung, Lettendarte, Arch. Section 8, 1808

Pusher Leavening to the form of the School Leavening to Mr., 64 pp.

180. To be resident in high section of the School Resident in the Sc

Voge-song to Excepts, for 11 to 185 Voge-song and Gregorie Leber to Same for 18 sample of a mechanism of general Marce In 1 age to 137, 50 2 to 15000

A. W Wright. Gines in smake marts. Am. J Sc., 21, 200, 1841, Radley. Notes on t restal on Mr. Mag., 9, 201, 1801

Vator. Das Wessey der Krystalluch. Zs. hr., 27, 505, 1896.

### CRYSTALLINE AGGREGATES

273. The greater part of the specimens or masses of minerals that occur may be described as aggregations of imperfect crystals. Many specimens whose structure appears to the eye quite homogeneous and describe internally of distinct crystalization, can be shown to be composed of crystalization grains. Under the above head, consequency, are included all the remaining varieties of structure among minerals.

The individuals composing imperfectly ervitalized individuals may be

- 1. Columns, or fibres, in which case the structure is columnar or fibrous,
- 2 Then tuming, preducing a lamellar arrichar-
- 3. Grains constituting a granular structure.

274. Columnar and Fibrous Structure. — A mineral possesses a coltampar structure when it a made up of singuer columns, as some simplifical When the many lands are flat even like a kinfo-blade as in kyamic, the structure is said to be bladed.

The structure again is caded fibrous when the numeral is made up of fibres, as a nedewice, also the satur-spar variety of gypaum. The fibrous may or may not be separable. There are many gradations between course columnar and fine fibrous structures. Fibrous numerals have often a suky luster

The feel wing are properly varieties of columnar or fibrous atructure

Retireuted when the fores or eclumns cross in various directions and produce an appearance having some resemblance to a net

Stellated when they reduce from a center in all directions and produce

star-like forms. Ex sti bito, wavenite.

Radiated, discreed when the crystain radiate from a center without

producing stellar femis fix quarts, subnite

276. Lamellar Structure. The structure of a mineral is lamellar when it consists of plates or leaves. The laminar may be curved or straight, and thus give rise to the curved lamellar and straight lamellar structure. Exwednatorate tabular apar), some varieties of gypsian tale etc. If the plates are approximately parallel about a common center the structure is said to be concentric. When the animas are thin and separable, the structure is said to be foliaccous or foliated. Mice is a stricting example, and the term successous is often used to describe this kind of structure.

276. Granular Structure. The particles in a granular structure differ much in size. When course, the numero is described as reconsequential when fine, fine-granular, and if not have againstable by the nakes, ever the structure is termed impolpable. Examples of the last may be startlyed in granular crystalline limestone, sometimes exclude another of the second, in some varieties of femal to of the last in some kinds of aphalente.

The above terms are indefinite but from necessity, as if ore a every degree of fineness of structure among mineral species, from perfectly impulpable, through all possible shades, to the connect granular. The term phaarro-repatative has been used for varieties in which the grains are distinct, and crypto-crystaltize for those in which they are not discernible although an indistinct crystalline atructure can be proved by the nucroscope.

Granular muterals, when easily crumbled in the fingers, are said to be

francia.

277. Imitative Shapes. — The following are unportant terms used in describing the unmative forms of massive minerals.

Rendorm. kidney-shaped. The structure may be radiating or concentric

Ex. hematite.

But you led consisting of a group of rounded prominances. The name is derived from the tareek dorpes, a bunch of grupes. Exclimente, chalcedony, prelimite

Manuallary recensbing the botryoidal, but composed of larger promi-

pences. Ex. malachite

Globular spherical or pearly so, the globules may consist of radiating libres or concentric costs. When attached, as they usually are, to the surface of a rack they are described as implanted globules.

Apitular in tuberuse forms, or having progular protuberances over the

attrince

Amygdaladal almond-shaped, applied often to a rock (as dadam) containing discond-shaped or sub-godydar nodunes

Constituted true cord, or extending of interfaced flexuous branchings of a

white cot r. as in the variety of armonite railed flow fort

Designation heart-bung trees the, as in any stalling of gold. The term designation is used for smaller forms even when not crystalline as in the dendrities of manganese existe, which form on surfaces of lancetone or are inclosed as " if one-agents."

M ssag like most in form or appearance.

Fuform or Capitary very stender and long, like a thread or hair, consists ordinarily of a succession of minute crystals. Lx milerite

Accordant slender and right, lake a needle. Ex strompte

Retradated autone See Art 274.

Drusy closely covered with minute implanted crystals. Ex quarts.

Statestate when the mineral occurs in pendent economic, evinders, or elegated comes. Statestates are produced by the percolation of water, helding mineral matter in solution, through the rocky roofs of caveras. The experience of the water produces a legislit of the mineral and ter and gradually forms a long pendent evhader or cone. The internal structure may be imperfectly crystalline and granular, or may consist of fibres cadating from the central column, or there may be a bread cross-creavage. The most fuell-lar compile of stainctites is afforced by expend. Chalcodory, gibbatte, liminate and some other species, also present stalactitic forms.

The term amorphous is used when a mineral has not only no crystalline form or unitative shape but does not polarize the light even in its munite particles and thus appears to be destitute wholly of a crystalline structure internally, as must opal. Such a structure is also called color fut or pelly-like, from the Greek solds, for give. The word amorphous is from a pressure.

and popper, whape

278. Pseudomorphous Crystais. — Every tenteral species has, when distinctly crystalaxed a definite and characteristic form Geossona, y, however, crystais are found that have the form, both as to angles an I general tabit, of a certain species, and yet differ from it entirely in chemical composition. Moreover, it is often noted in such cases that, though in activate form complete crystals, in internal structure they are granular, or waxy, and have

to regard closing. I very disher the crystolice in structure the optical dates is to the data to use removed by the symmetry of the frees.

She reads to the data to savely and a reconstructive seas, and sally contributed to the original material has there to good about the reward pointed or the disappears through some particle is a probability of the material compound to which is a probability of the material compound to which is a probability of the material compound to which is a probability of the magnificant pointed or structure of the first particle particle

the conductive section to the term of pyrate, but the form of questions to subject the term of pyrate, but the form of questions to subject to the term of the action of the pyrate, but the form of questions to subject to the form of the pyrate and the pyrate and the pyrate of the p

Manufolgy.

# PART II. PHYSICAL MINERALOGY

279. The physical characters of emergia fall up to the following heads: I Charmy on depending upon Cohese a stat Landedy was clearedy. fracture reasons haviness elements --

If Specific becomes of it from by suppose and that of as the

111 ( far cerers leper long upon loght via odor notes pigne of traffic

parency special optical properties, etc.

IN the extens depending upon Heat are law seen money a hunge of form and of space characters was act angent to sept to fine bity or

V. Charmeters topic long a pan tree to city and With a com-

VI Characters depending what the act r t he selves Mrg. Paste.

octor, feel

280 General Relation of Physical Characters to Molecular Structure -It was seef shown Arts 30 32 that the greaters, form of accept axed amongst a choose produce posses to of the party and the english executive. It is pantriotha hentern stribitery party of the places have ers listed a traced by to agraph, and the restale a . . . of the iterestated ing of their energy. All the person of paper per depending of the best of the chemical part of the first period of the period period of the period period of the period of th those upor the way which their ite or rearranged a excessly regular

till they che part by the specific gray & specific green with a specific to at rije it ass of the leaves a resent and the ver of the second me associngarpegation. The tree of these points is quetrated as the high special gravity of extrapolated for the second of the distriction of service the example be ween eather in as former the digital and a survey of 3.5, and the same charged substance as the internigrant a with a spa-

culic gravity of only 2

All the allier characters (oxed), the relativity in an animal result case If it generally is arready to the district at the erroll is a factorial to they have a delitate as I at Tarnell of their or residence in a

which goo , becape it is a feel has the physist chi.

In reg re to the men a present or st. the hardle of a consulagreephore and some the events we can also be the total on the terms of I pure to disporting to or will be as present a trace my fer . creation of the administration of selection of the property of the le soul graph to the terms of the contract before tes, the planes and beight age theretag as most or the comment in the ease of parents that the appropriate

It can not play to a same a sally serve the characters which the new hopes good and a spile tradeger on the d Crange of or service for the contract on a great contract.

Hus, a hought to a world but pay of the paor rest and in agreement at gets the with the synthetry at most true they at his early

all the variations in this symmetry. It is true, for example, that all directs inside options is at all this directs is along to any class under the isometric system, but it is a type, so he true of its discretary cohesion, as may be shown by the converge. Again all direct is in a tirring on typical right and est to the vertical answer of the visit to the vertical answer of the visit to the vertical answer of the visit that the description of the special characters of each group.

### I. CHARACTERS DEPENDING UPON COHESION AND ELASTICITY

281. Cohesion, Elasticity — The name cohesion is given to the force of attraction testing two contributes of our in the same tests in consequence of which they effect over those to any its consequence them is in the break gradue. I way or in separate them is in the break gradue. I way or in separate them.

this, it, is the fere we cheen he a restore the residences of the residence and their engine position from which the least see a detached, so when a

body has suffered I age of so is the first to the entire of

The varing distress of ed size and easier to fer crosside of different Balberals of fer different dater has a the same took of the fermional characters assume the fermional characters assume that the glading planes percession agrees or present distress as a few many terms.

282 Creavage contage is the relative of a cryst most a unit to break its certain cefts to asserting a vicinity is one or less error to influence It of viously on a test and unit value of not so to the decision of easy fracture. On it is now not after decisionages proposed to the cubic faces of a crestal of gradual established an indistriction. An annexative cubic faces of a crestal of gradual established an indistriction.

photo batt the property that it was a consider

Plates of come go de always of near of the cres al structure and therefore are partied to peach person faces. These errors plane has an derelations to the error diagraphic axes and see is a vicin not a generally forms on the crysts of quest hands the felt always runge at an to the cases of fluor cape call to a constant converge ( one consist survey) to their crystal grapt is relations, set it were as in iral forms igon that crestain. Further counge is the same in all the a new acrysta which are retatabographically ments of the office of agreement personal so one octafeeter to the state on the cate offset the car the same at the state of the cate of case parties to the three after a medial prime that go panes have er ner environs been assumed to be those plants if he atopic struction in which the a blue are in et close's packed together work the distance he were the sticcesors e planes is resultively surge. Cold, a new of his sort are in boubtest y in iterials in letero teng the existence of cleavage but they campo by the only controlling factors. For motorice it has been shown that splanterite and the four-old have mostly entire, entructure, but it one case the conveyee is dodecabeen, and in the other or thedril Cenange apparently depends but only apon the geometrical posts to of the conservert at us out sign upon their eastronic organ. The electrical fires custag between the different dayers in the grount structure are of great traps chance and cleavage taken place, when the atten tive forces are at a test motor.

brace cleavage commonly takes place parate, to some fundamental

crystal form, it may be used in cases where the choice of the position of the crystal axes is more or less arbitrary, as an ant to the proper orientation of

the crystal in question

the war age to defined (1) according to its direction, as cubic octahedral, then about bean premate etc. Also if according to the case with with it is of tailed, and the sin a thress of the sacrace via def . It is said to be perfect or cranical when it is out a cut with great east all pring amounts. harrons a triaces, as to much to true, our to before the green of character are survey of na district in leavest or imperfect intermeted in traces, difficult They terms are sufficiently in other e will return captains to It may be a spent that the coarrage of a species is sometanes better deven ped in some of its varieties than in others.

283 Cleavage in the Different Systems. - 1 In the as-Market System Cleavage in at when wratte to the faces of the first this a third of or as an attack by given and the a last use diep at home the new house he as a retain took as is to the enter the time of the form the part of the descent of the form of the time. of the the businesshoote as we happened to

In the reviewe with a street uses are a first basel, or parallel to be heard place as with any divine also property or some or rich to a manage or also, as with ru 'r ar wen ente fee feeques is it is pyrumika ie paralle i the faces if the source

payrunts of the to been to

to be ever as yet as every less age to arread vierber basest as with hered or presentation parameter of the executed grams, as with nephritise, pyronicial houser as with pyromany a serve and reperfect

I the til whood its, typics besides the basel and prime a leavage, chowho-And if its age marage to the faces of a rhords hearon, is am common, as with cause

and the send stee es

In the person at a state of the property of the property in contains to. These is a househout the beginner and to be non-greater to be an observe and a section of the material was superior as assessment to the section of the sectio These I a harm's while beginne un i to a men junior had ever a caw to a force may red in Jane ribing the crystal may make that caractage parasist to a burnamental prism,

I the movocatery everys clearage parallel to the cuts presently in outside, as with terthism man graphings. Summin the triple on make in the former is to the main a return to the or par el o be arther and man permate as with neighbole [am feeping day

cross age is party of to a british primary when it as will go well-

To be The the streets to since we are the superintental form as to make the cleavage directions retries of with the since with

284. In some cases manage is to as in the statement man be one god by a sharp blow on by sudden change of supers in this arts in states and in a v from the meanings but a constraint bearing and a more than the second of the war a second of the sec we be ded the pew attribution of the other to become with great astroctores in the methods souds by great ig with a disputes ay become in any or whole

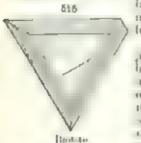
When he cheanage in , we let is a colored two this is when is the inchalled and described and or chief a restraction to produce has in the entraperational and only or the the se markette accept properly being was not man bet by chiled in limit a stage crisical for reliant and an artifact traggers to our other and windows. It is to greatly not to use good as an lessage form, as a newage or abecome of fluorite, from a true crystal by the sees observed at the faces of the figures.

286 Creavage and Luster. The face of a creatal parasel to which there is perfect that age often shows a present further many 25 the to the second separation of the creates the parasel parasel of the boson parasel of the creates as the control of the creates and (eropee

<sup>\*</sup> Lebitishin Za Kr. 11, 606, 1986, and Just Min Mag. 5, " 1988 regard these as glading-pisaces see Art 106).

286. Gliding-planes. Closely related to the cleavage derections in ser consects to with the concessor of the replectiles of a crystal are the gliding. purpose of the purpose part sel to within a tipung of the teolerales amy take place a per the apparation of mortanical tiree, as by pressure

Plant is a see to real of samply producing a separation into layers in the given the jor, er, on the other hand, and in a country by there may



be a revenue at an of the near these path a page twitea g-position so that according by amon-lamella are lurmed

done if a creatal of anote or rock out be subpetec → gradual riessure in to direct in of a dodecahard fee and the of separate a sedevale and horse the table ager is the direction of another face or the same form. It go go spe such proper as if probabiliship as a disease on a a cristal filles. safet mee. Cer an a lefs of mea of the Lintite class. come the perulaserasto in faces, while are indoubted a special its in orders. That is, I are been de-

volue of the presents exerced a disequently to he grow had the reyard cef-Fig. 515)

I sale to the binn of ODL species to the plane of serfect classage, an gooding cause The and or determine was all legal in setting of an opiner y the sing to the proposed may be made a round by suggest being a his too.

287 Secondary Twansing The other oscine there did the preceding at the white to go or a spring a act a papella a reflected day a tiber of the person of the remediate of the person trit I by cather Press to pour a syspering color in a roop, in the former and an inches of the first of the ting posted of the parent mass, the our get in long to it or negative elephancen, et 1 2 becoper two is a district or to those me often beersed a metaral cleanage proces of calculations and processing it the grants of a 615 that has a first for as observed an above an up or

the microscope. Les ber dest extend for the market of the tendent upontary to col the upon to be easy of the trans- fold-BI AT IN AND LATE OF A SECURITY LOTE OF STREET the greatest has not been odered as during all all a the landat consisted of right-hannel at a left ranged

portions. he the proper sectors on professionly twin has we have boundy power of the territory and total Artificial Twinning I my any own , bought have there a , if we septime the

then do not be a substitute of the control of the c terms armine than the constitution is his new appropriate and the both of terms tend by the ery

288. Parting. The secondary twanting phoses described are often directions of an easy separation convenies, year of parties; - waich may

617

he mistaken for cleavage." Parting may de occur along glading planes. The hasal parting of pyrexche is a con it on extration for a residence in geit was my matricen for electrice. In page and remindered (11) un , the less hattied presented that parting of corticle in the optionality parting of a good to of hig 500 p 108 are charge uples

And interface the nation between he a good december is partitional expl a vin cer to delete the course that a street of with ganother whose the clearage may have paire to day had before the group

t regiter.

289 Percussion-Senses. It weder the converted with the gliding. and something temporal and the company of the second and a state in matter to a law a passage with so discount la such cases the metral leser by serves or surprise or less we lead to the state whose or to that a disswith to created grapher dendment to soften and an teette for forest floor arrest str slapes, fagure is produced with arms in the compapolar that was not be to the order of all an eserute net thought Care a tresseries of some a harm

Disperension figures in the case of the ratio bases in beer aften trace givel and, a new irkest liver they from

mark of hyagalicity or and a file gop of he ving to year the outlines the tight and \$17 are and early star into all whose I rate tracks part, and the contract of the con of test partiables to the tester of pages for open a statement.

Prior of operation of the properties of an antique agent serial agents.

Cother, as moreal, this a collect a person to the

290 Solution planes. In the control is at the property to the extate of the section of the contract of the con a high a ser

These sections as the section of the nor Art 378 America) is see and uniformly in rocks (on distinge, untillerapur)

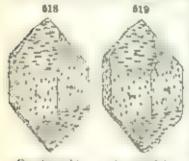
291 Etching-figures. It was to there or with the general subports they considered of colleges up to me I cross no me the prepriet price dured by a hogothery tollier larger person for a the state on any in Dependent of these gaters developed over art, by Barmbarre and high if perhatogues receiving the ready the structure of the cryst times are no exillates of stall there is the south try of he cross a ter-

He ending is preference in a manager of the water in some ensure from generally to against after our to open at alkalase on both at the

emps from more a bart common. I have been a set of the part of the part of the rail the sight committed one I which is been a large of the sight committed one I was been as the sight committed on I we I will be the sight committee of the sight been a large of the sight been as the sight to be the for the second of the sight of the sight been as the sig

The limited proteins the subset of the set of the first between the tree of wife states of the set of the set

a high pressure and hydrofluoric acid, the last is especially powerful in its act, in, and is used frequently with the sincates. The hydres produced are in the majority of cases angular foppessons, such as low triangular or quadricaterid pyram as whose outures may run paradel to some of the crystaline edges. In some cases, to plants produced can be referred to constrain crystaline edges. In some cases, to plants produced can be referred to constrain crystaline faces in the often they are of the batter of victim faces with com-

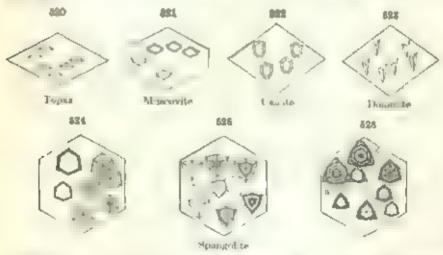


Quarte eight has be cryotal

Quarte lefts but we cryptal

preated to arow or are in fact curved surfaces. They con monly be however, in definite and sample crystall zones. They appear aske on smalar bases of crystals, and hence serve to disamptesh different forms, perhaps in appearance decrease, as the two sets of faces in the crelinary bomble pyramial of quartz, as, two, they reveal the crippianal twinning-structure common or security at lass quartz and arraginete. Further, their first in general curresponds to the symmetry of the group to which the given crystal belongs. They thus reveal the trapezonedros symmetry of quartz and the difference between a right in a let and left langual crystal by generals.

518 510; the distinction between electric and discented P gs 522, 5231, the distinctive character of agent to pyromorph to correct in her manufacture with the contract of the 256, p. 118, etc., they also preve by their form the monocliber crystalization of museov to and other michaetting 521.



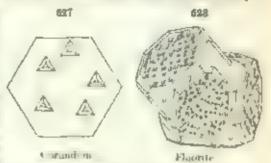
big 520 shows the eleting by true framed on a need plane elements of topic by I and constitute of the electric state of the electric

The across of the olding figures in your as hithe autor evenly with the nature of the solvens unighes od, the opt shows succeeding to make a continuous for example tog. A believe

the figures of a ned with springelite to the second of siphiness and Fig. 5.65, by the same distributed and Fig. 525 by hydrocolours and of Hamilt degrees of concentration.

Of the same nature as the etching-figures artificially produced in their position to the symmetry of the crystal, are the a arkings often observed in the attinual faces of crystals. These are sometimes secondary, caused by a

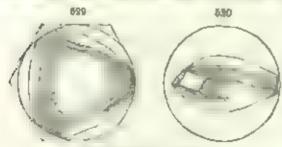
priors etcong process of section fee an irregularity in the crystalline development if the crystalline development of thingular depressions often section the octalistical fixes of the irregular depressions are in x-mate. Fig. 527 shows notices of ressors, ricembolistical in dispersions, ricembolistical in dispersions, observed or costal in dispersions of the irregular depression of the irregular with a fee crystal of the rite with



where the property of the present the same manufacture of the depressions where the present the traperty of the straperty of

293 Cerrosion Forms. If the entiry process epocen of its the presenting when whether their is rated at a stronged he result may be a possible right ery. The surface of to substitute for it perhaps a rule to the of its air cost in its more or less better or, further new faces the be developed to cryst begrephic peer on of which can often be let a mined though the seints learny by compact. The next loss of water in senite ences produces certain our cover forms.

Section of the property of a section of the section



Istehen Sphere of Quarta

hard 29 Shi there is I me retractory ofter the others and boars etches, for never weaks; his 500 is a local view, by 500, a front energy the circle shows the original form of the sphere, the detted because the post of of the axes.

293. Fracture The test fracture is used to detion the firm or kind a surface of transed by breeding in a direction other than that of elegange is crystal-

lized extrocula, and its any direction in massive man-rals. When the cleavage is that a perfect to environ. I rectainly, he the rhumbohedral eleavage of calcale, tract is in ten not readily observable.

be come in I dined in

a) (mach old where a natural breaks with curved concavities, more or less deep. It is so called from the resemmence of the concavity to the valve of a shell, from conche, a shell. This is well illustrated by obsidian, also by

flint. If the resulting forms are small, the fracture is said to be small-conchould, if only part ally distinct it is subsyncholded

b) Even, when the surface of fractive though rough with numerous smal, rievets as and depressions, still as preximates to a blane surface

(e. I meren when the surface is rough, and entirely arregular this is true of thust minerals

of Hackey when the elevations are sharp or pagged, broken ron

Other terms also en plexed an earth, apastery, etc.

294. Hardness. The handgess of a moreal is measured by the resistor cow ach a smooth surface offers to al region. The degree of Earthess is determined by observing the comparative ease or difficulty with which one nameral is seguitehed by another or by a file or smile

to manerals there are all grades of hardness from that of tale, impressed to by the figger-mail, to that of the damage i. To go e precision to the use of this character, a scale of hardness was introduced by Mohn. It is as follows

	Tola.	6.	Orthoclass.
2.	Суркат.	7	Quarte.
	Culcute	8	Tepaz
	Francie		Cerandum.
5	4 partite		Dramond

Crystoffine varieties with surfaces should be taken so far as

Diretestade

If he mineral inder examination is sensited by the kills blade as castly as call cost ordinas is said to be 3 of low easily than rule is and more so than their rate turdress pra 5. In the apprecise he marred a question words, he a neterior by themere but we also said samples endeds. It you her ly be added that great are ducy a not attachable by the above methods. the ghe midesel, for purposes of the determination of minerals, exactnose is United the street on the

It stored by notes that numerals of grade I have a greasy feel to the last I. these of green 2 are casely scratched by the finger-hear, those of grade 3 are to her really cut, as hy a krafe of grade b, seen that rather cases a by the ke for gen to a specifical wait so or I the iter, grate the burre y some other oy a know has a mostly by a lite moreover they was appared oregin by glosse M. ross natural assumers H = 7, or her or second glass road year tro if it in really a file the few species be origing lere are an americal in A penory H, they include on the geme

295. Scierometer. An rate determinations of the hardness of minreme can be made in various ways and fifthe rest being by use of an institument called a scienometer. Ten not up a panerel in a m valid carriage with the six are to be experienced speak to rigerita, this is brought in centret with a strel point or distourn point fixed r compart hove, so weight a then determ not which is put a fit can to take the carriage and produce a scratch on the surface of the nyneral

By months of such an instrument the hundress of the afferent forces of a given crystal has been detertained in a variety of cases. It has som found that different faces of a crysta, rg, kvance) differ in partities at I the same lace may differ as it is scribbled in different directions. The legree of ease with which a given numeral is scratcard to a it easure of its molecular cohesion,

and in cases where the echesion varies with the direct in it is obvious that the leadness win blewise very In general differences in hardness are noted only with organila win hash a dierroit cleavage, the bardest face is that which a intersected by the plane of most complete convage. Further, of a mage face which is arrespected by electrige-planes. To direct on perpendicuar to the clearage direction is the softer those paradel to it the barder

This adjoe, has been prestigated by Earner p. . , who has given the form of the curve of hards of a their their florest factor for a very store. Then our is are obtained as follows the most weight recurred to seem on a crys no in a close to dispersional in each 10 or 15 arms to to 156 in no orninged by the insure matter chapter of the interest of the contract of are find off as to I. In an a consert and the english back than a propertional better weight fixed by experiment that a to to birthess than engineed the one connecting the

extremition o these make is here over it arrives for the given face

The following able great to restors thin all see heratore in our paring the hardness of the scale train or at m, > 9, taken as 1000 to gapetain, so it littled pred the last on of harang a than anterest and the nature or or or in error ped by the number of rotations: Rossina) see a standard powler to grant the surface logger explicted has parried and another the trethed cour over tally a manufactor of that of Plat by the good of this party ment be so at it to one of the there of the metals present to a than section that the mirrow open Manager or to false he have there have men made And both Helm on like teent anote want nothers tent a feet granting me had Hor rough to with regard to the minn era a of the sense of his brone agree facts and but the thomas of Rosses, given below to take w consider the contrepancies with the rest to obtained by the atom on high the he Housen, their that topes in ower of the sense dian quarty.

	P	fall this	Hor wal. 1892	Jaggar 1807
9. orandura		1 1 1 1 2	1000	E0000
S. Topice		400	, sh	152
7 Security		. 54	119	40
6. Orthoctake		10	257	25
5. Attetate		83.8	0-20	1.23
4. Electrica :		87:3	4:70	75
3 talien		15.3	2:58	,26
2. Сурвит		17.08	-34	-04

206. Relation of Hardness to Chemical Composition. - Some general facts of importhe enterior of marginst a regard to the amangement servered the burelesses of a mineral and the eminal company on

I they want to of the best y metals, as office, copper, mateury had, old, are self, their

hardpean seld ..... second ag . 5 .... t

An ing the in managers of the presence stateds the might be are used and readers of atms also of carbol a 1 chart open at celebrate as for a mell to telebrate. the H = 0 et here being a so commette don alcourte lunta le, son ignituate wolfrande our bragionie.

I The so also a see must a relatively soft except as noted at 1, also must of the

rationates sufatutes at 1 th at the 2. The primate astroctly above attorne in attention 2. His reas also are ref ( ) of . There most castinetty above attorne in attention

- e go, e and and they have make and see a se-

4. The consequences to be an anomal series of the consequences and statement many of them are a pain is contact up to marita any or a to a consider clayer. here), and may a common makes. Untaile or these he to rate so made to have H = 7. Admit they introduced

the the resultance hardness to equally gravit, see Art. 307.

297 Practical Suggestions powers points the lit by regarded in the trials of

I If the numeral is aughtly altered as is often the case with report the garrent stethe auriant way be really to a fire a fire a settles will a be a price to a till for transfer side ( a trul with an edge of the latter will often give a correct result of 4. h a case

<sup>&</sup>quot;The manders are here given as talmated by Juggar

f bor farther in Appen of B.

12. A interest with a gran far mulace often appears to be scratched when the grates have been a visit apart or ensure. I have a faint write ridge on a surface, as of game, when can be a daken in a series of careless visite as

4. A creater and courts, a often of ght's acre about a the edge of another of the same Species on the intile on

The arrate amount to turns it such a way as to helighty too spectures as little as possible.

298. Tenacity Minerals may be option britten section madeable, or flexa le

a Brutte when parts of a it metal separate a powder or grains of

ofter plang t cot it, is nalong

the Safer when press that he cut off with a kerfe without falling to powder by still the correct payer as their a latiner. This character is interpreted as between brittle and me, only as gops in

to Manuface when some may be not off that one shows finitered out

under a harmor matrix gold, a live silver

of blanker when the nones, we bond without breaking and remain bear after the oeb ling force a reproved, and in-

The term of a same super is proper to consequence of the object city.

290. Elasticity - The clistiats of a sate (early expresses of once the reme ance which it do new to a case ago it was preceived in a med about a log deriver to principle by the medical whole the country of the courses much all the tract of elastic to us nest primited. The desired a made out primite are preparetically ter the fire noting in hitse femine along or years man is to restricted of this large a excessful alle of formation becomes permanent, a new position of to negurar equals read bacteria are resulted as a state was a the photon eng of grand planes and secondary two way already discussed. For ringratele of the established to the state of the electricity or, but it the courts and I read discre This is defined as the relatop serve against a soprofit of the post of the post of a borrolling some of the files. being to procure his offset and only of the brading it woning for our The supplier was cur's three-lighted manchingly by he are in people yours, Verge and outers have no do me trade to remove all to a needly of motion subcancer and diff crystale the and substituted literat processes The among the pleasons at our to return the changes in value with charge of crest, I graphed account to a grayers

ear discret to be seen one to and at the in her much at ween the numbers of action group and about to needs. Make a contract of a the colors of legal topoler and plant pite in a man fe the cast Harrist to the physical series of it be served have a bagin victor of the coefficient from the propertients as eather in the facilitates consticity

to dispunyed the light unusually wide units

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#### Harrings.

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Auerbach, Word Am. 43 for wit 45, 262 277 1892 56, 367 1896. Ros wat Vera as line at 475, chart Verb c, Brantat, 1916, Mott Worder Min. GPX NC NO 69 917

T A Jaggar Jr Marmoclen-outer Am J & 4, 199 1807

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eter a 0, 1m

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#### to time claims, becombing Tommena, etc.

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] W Judd Sol trong or metr Q 2 % we 42 v 1 1005 Min Mag 7, 8 , Yoigt ber below

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Severt A. S. P. St. v. 40, 5 1 1 1829 also in Page Ann., 25, 200, 829.

Ne mann s on to 31 wit

Argumen Page v 66 hr 15 180, 300, 1874.

County University 5 to 187 (16, 0076),

Tatton. The frage a motor is read the most on and Cheen as I was I done, 1996.

### IL SPECIFIC GRAVITY OR RELATIVE DENSITY

300. Definition of Specific Gravity The specific graves of a cameral e the princed its access to high in a depart 1 ( 30 2 ) , seems, the he to a special problem of the contract of the Certains there is given a primer to the identity in a second value before the specific grants and a school to trust another weight of the way to test by the energial of an or as a some of a store

<sup>\*</sup> For en to also pute to be two to be all occurs. It is an her motes the le . am a to local a fine the agree of a fire the to all fine water make it served to recover or mend by a contract of the recover Myes by gray 3 a the ra w or the second, to the .rat of agont.

The statement that the specific gravity of graphite is 2, of corundum 4, of galera 7.5 etc., thesas that the densities of the minerals named are 2, 4, and 7.5, etc., times that of water, the other words, as tannearly expressed, as yourse of them, a cube in a for example, weight 2 times. 4 times, 7.5 times.

ete, as med as a ske volume, a cishe men, of water

Streetly speaking some the density of water varies with its expansion or ech raction in derichange of temperature, the comparison small be under with water at a fixed temperature namely 4° (-30.2° f), in which it has its information density. If it ade at a higher temperature in an table correct on about the introduced by calculation. Principally, however since a high degree of accuracy is not often called for and indeed in many cases is injured table to it aim in consequence of the pature of the platering at hand in the architecture of a taping the degree of accuracy with it of patures of the pature of the pature at the temperature at which the conservation is marke can safety be reglected. Common variety, has if temperature would set in affect the value of the specific gravity to the exact of the pature of the specific gravity to the exact of the pature of the specific gravity to

For the same reason, to not necessary to ake into considerable the fact that the observed weight of a fragment of a manera, is used tool to true weight

by he weight if air dist are a

Where the nature of the investigation radio for an accurate naturalist on of the specific gravity to g, to four use u.s. Leon involve of the precisions in tegral, to be prody of tratest, on those of weights, conserved to appearative the combine reglected. The accurate values applied of me treshelp in the cormiteration of such problems as the specific volume, the relation of

in some volume to specify gray than dimens others

301. Determination of the Specific Gravity by the Belance — The threet comparison by weight of a certisal volume of the given innered with an equal volume of water is not often practical e. By the eigened however of a functor principle in bydrosial excitation as a latent or principle in bydrosial excitation as a latent of married water in consequence of the housest of the context been in verget an arrown, which is equal to the weight of in equal volume of the water that is, the volume it dispenses — In deterious som of the specific gravity becomes a very supportrocess.

The weight of the sold in the mertal is first determ and in the anial connect then the weight it was erist touch man, the difference as tween these weights that is, he has by connection a new some weight for you not of water equal to that if the wild highly the product of the first weight to by that of his equal volume if water as acternated a - a , is the specific gravity (G).

Hence,

A common methor, of a blanning the specific gravity of a firm fragment of a fireferal is as fewer has weigh the specific accurately an agood of emeas 1 mater. That weight if from the pannol in balance to a breedom with thread or, better stable to a fine platform war, then glass of water conveniently placed beneath, and take the weight again with the same care, then use the results as above directed. The platform were may be wound around the

specimen, or where the latter is small it may be made at one en l'into a lattle

entral support

302. The Jolly Balance. Instead of using an ordinary balance and determining the actual weight the stand common of Jolly shown in Fig. 531, may be conveniently employed, this is also a stable when the mineral is a the form of small prints. The ask to their exists of a spiral spring of the lower entrol which are suspended, we press or wire reskets, can but, but Blower entrol which are suspended we present makets, can but, but Blower entrol which are suspended we present in the water. What in adjustment of a read by this stand has such a position that he pain the immersed

at the water write camps above it. Upon the iteright 4 there is a narror apon which or narked a sect of 11 posses tipe the balance a may time as blanked by so placing the eye that the last, or and its relection in it sturring cor a team a their reading the position of the cop of the best upon the scale (the first stepping the operation or taken). get by the prestie. The spring is no, isving the pair d man poet in the water in the beaker. Let the reading be represented by a . The mineral whose spacet gray to is to he foreign and is then placed on the pain or backet a and the protection. B record antil disc properly insurred in the water I'm position of the boad #e st gain real Let this value be represented by Y. Hifrey V acsubity codthe manher recognizing the amount to which the second scretches a the weigh of spring at 1 paint along, the life ference will be proper or as to the weight of he mover ! Next the impress is placed in the lower part of, impressed it he water just gave be corresponding scale pumber As read. The difference between these natings A -Not see that boy proportion is to the loss of weight in water, The specific gravity is then

$$Q = \frac{\Lambda}{N} = \frac{n}{N}$$



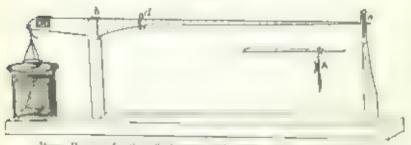
It is obviously necessary to have the wires supporting the nower partinents of the three determinations. If each is taken the absence gravity can be obtained accuracy to two leginal pages. A more improved form of this palance has been devised by Krimas, see reference below.

303. The Beam Balance. A beam to once described by Penfeld is stricted very scople and to be ascended divide for measuring the specific gravity. It is discreted in Fig. 532 while will make chart sussential parts. The beam is so beamfeed by a weight on its shorter end that it is very nearly in equilibrium when the lower pair is any itself in water. An exact balance is the outlast of by the small refer d. When he beam is once balanced this mean is specified in the subsequent readings. The innear his true paners in the appear pair and the beam balanced by another refer of such a weight that its position will be near the outer and of the beam. The position of this rider is then read from the scale engraved upon the beam better this value be equal to A. The it nearl is next transferred to the lower pair and the beam again brought into balance by moving this same rider back.

The accoud reading may be represented by V. The formula for obtaining the specific gravity is now:

$$G = \frac{N}{N_1 - N_2}$$

830



Bran. Planece for Specific Gravity, 4th Autural Sign infer Pontage

304. Pycnometer—If the anneral is in the form of grains or small fregments the specific gravey may be obtained by east of the parameter. The sen small be the chig 183 baving a support which fits tightly not or lead a table with a very fine opening. A number of lifecont types of bottons are used. The bottle is filled with distribution water the stopper best of the averthowing water curefully removed with a soft cloth and that we give have neverthead whose density at to be determined as also we glood. Last the bottle is weighted with the in never in the site of with water as deserting



Pyenometer

above. The weight of the worr his area, by the internais a vicincy the difference of weer this last neight and but of the both filler, w. waster by the weight of the interna-The specific gray by of the numeral temporal to its weight of an deviced by the surget of the numeral temporal to its weight of an deviced by the surget of the neighbor to whater has the termined. Where the method is followed with softward care, especially avoicing my change of output on a the water, the results may be highly accounts.

If the mages, forms, porcessors, it may be first reduced to powder but it is a beau and that a has been above by Rose that element predictes have unformed a ligher density than belongs to the many substance in a less time y divided state. This inchesse of density also characterizes though to less extent, a samual to the state of incomata-

ral subdivision. It is explained by the concentration of the water on the surface of the powder,

306. Use of Liquids of High Density — It is often found convenient both at the determination of the specific gravity and in he meeting cal superature of fragments of different specific gravities e.g., to obtain pure a stemal for sunlyss, or again in the study of rocks, in use a liquid of high density

<sup>&</sup>quot;Cure about the taken to prevent or both is be a mulated among the mineral particles. If is not be accomplished by a complete when the archer angle and let an air particular and the archer and the archer and extra both a substantial then advantage to could again orders weighing.

that is a so-called howy solution. One of these is the solution of mercuric toude in potassium tochde, casted the Sonstadt or Thoujet solution. When made with care it has a maximum density of nearly 3.2, which by dil isson

may be lowered at will.

A second solution, often employed, is the Klein solution the horotringstate of cadmium, having a maximum density of 3.6. This again may be lowered at will by dilution, observing certain necessary procautions. Still a third souther of much practical value is that proposed by Brauna, methylene todade, which has a specific gravity of 3.324. Userses solution, composed of equal marts of thad an fermate and majorate has specific gravities above 4.00. see below under laterature. A namer of other sol and more or less practical have also been suggested. When one of these boards as to be used for the determination of the specific gravity of fragments of a certain maneral P noise be diluted and I the fragments and float or I the specific gravity then obsained, most conveniently by the Westphal basance Art 306)

When, on the other hand, the ligant a to be used for the separation of the (regreepts of two or more internals mixed together, the pasterns is best rest ,cost to the proper degree of fineness, the dust and another fragments being of ed out then it is a treat need into the solution and this dileted until one conat the tafter apother wake and is reported for the convenient application of this raction, a sustable take is called for and certain presault as must be observed, see the papers acted in the literature in 222, especially one

by Penfield.

306 Westphal's Balance - The Westphal balance is conveniently used to betermine the even his great to if a light and better of a min on when a heavy some in the contract Art 300 It constant we stalk of a groundles at release are at the control of the stalker in an appended to a fine ware. The arts in so anyther at the position to all the station a resulty restaurage and to purish our beneated. Against take on the original than it whose specific grants all he leterina ion is more or that in sinker of opener in the The proof of transfer to again balance the arm wags to a the ferm or release are content again the graciante arm. These is to be some and that the nakes to tree appear to a the gracial arms that he arms of the wealth as I allowed that he arms of some many of the arms pour as the record the wealth as I allowed that he arms of some many of the arms pour as the record the wealth as I allowed that he arms of some many of the arms pour as the record the wealth as I allowed that he arms of some many of the arms pour as the record of the wealth as the arms of the wealth as the arms of the arms

307 Relation of Density to Hardness, Chemical Composition, etc. The legal of specific gravity, if a sect toporals first panels or are of the hence at industrance which

The mean way I mention of the test may be and the area to be are at high denied to T about to gover bend in a brace metal or changedly expressed has a bigh a a weight 200 to be a arty butto in a light a barrie has a specific greatly of a ", while for each a m phate or arrhydrate the value in only 2-05 atomic weight or bar as left, for cause on

In, the other hand, while a unimma is a metal of low density the a 25 and atomic we g 1 - 27, to real, come um, has a remarkate, high to a 1 - 4 are to a secure ture! If a ! Agnite, eachers (atomic weight = 12) here a light terrorty in the atomic if a .6 and h was green to (0, = 2); also the first a last) II - 1 the section of all will be and the section of the high steral and has great on an approximate tion, and hence it is atturn that it should be accompanied by great har new and recovered to the atta a of acids

to bearing upon the point it is to be noted that the decerts of man is betonces in actored to fix on Again, the same nameral of therees we see if once our age sure of may differ but only aligned as he say hersharmore administrations have give some change and composition have sometimes liferent denoting extremon ling to the liferest constable

Libertusen, Manual of Petrographic Methods, p. 549 of erg., given in detail an account. of the various solutions, the methods of their preparation, etc.

forms in which they appear. Thus in the case of calcula carbonate (Cal'O), calcula has

(1 - 2" or igon, to has a = 21.

308. Average Specific Gravities. It is to be noted that among numerals of NON been ad a rest the new years to great the manager from a date to d. Here being quarter to a rate of the fit have 24 2.75, immersive as A sective great to of 2.5 or less in one and in contract of a death a morning and after those wire are with in the Research and the second spectral transformed as apattle, venivinite, and the learning are section and operate in a common that and given common 1901 35 Augustic forms of a common transformed to large spectral and second large spectral and are second larger than the second transformed to the second transformed to the second larger than the sec TOO stage on or ser appear cours that are eff

Who we all dervice a transfer a stage salem where he my pyrite, hemat teetc. ab c. s. w. in is crim. en a w. gra, tate 2, at month 4" of 7 is above, regard vely

high how can 7.5

and sear for seads accorded according to their specific gravity are given in Appendix B. shornester of Randamental importance, and a ray is one at the release of the content of the cont en a march for the profit of a south of supplemental and asset of supplement of the profit of the second of supplemental profit of the second of the second of supplemental profit of the second of the second of supplemental profit of the second of the sec this a secretary to late at a not cause a synthetic of east a give to. The off court All the death of the control and the trainer of the leader of the at might so the soluble varying for the course will

310 Practice Suggestions. It also I also go had it. down at me the specific gray than the it is switte freign and taken is a few and in free freign and in the mail care externing and the man in the contract of the angeline and the first on the first one the first on the first on the first on the first on the first one the first on the first one the fir set and we menter that it is the entern before me to go me the water at 1 to the contracting of the part of a property tertified to a life a source of writer to be a maximum count by word to go as the an are a first again rate. No. is terior as the second of singles of temperature are rightenedly exthe gotter of a wester testing

and are a real to the signal a value and a second proportional when the appendix get as to all the transfer being with the all terms and the contract to be stated there. There

the second of the second of the second to be set as foreign of second further second of the second o consider the state even to afference be wron a record diamen which a quartit grystal, can be detected.

### Letter say we

Symple trendy

#### General.

Boudant, Pogg Ann., 16, 474 1828.

#### e of Heavy Solutions, etc.

Soutladt, sheet News, 29, 127 1874 Thought 11 Sec. Ma 2, 17 186, 1870 Breon P.al Sec. Ma 3, 4 Sec. Gadschmidt J. M., Ben Ba, 1, 179, 1861 D Kican Rel Son Mar 4, 145 1881 Robrbech Jr M 2, 190: 1800 Gisevius, Imang Dies Bant 883 Braunt. Jb Min , 2, 2, 1888 1, 145, 1888.

Hetgara. Jb. Mar. 2, 285, 1889.
Salomon. Jb. Mar. 2, 284, 1881.
Penfield. Am. J. Sc. 50, 447, 485.
Merwin. Am. J. Sc. 52, 4-5, 1-11.
Value. Lee and formation of Cleron solution. Am. Mar. 10, 123, 1025.

## III CHARACTERS DEPENDING UPON LIGHT GENERAL PRINCIPLES OF OPTICS

311. Before considering the optical characters of innerals in general and in the part chair y those that woughts be crystals of the different systems, it is desirable to cover briefly some of the more important principles of optical upon which the phenomena in question depend

For a filter limit amount of the option of cryption, specimic reference in made to the works of final tensals are a finite and two by Violana Disput and Pennse (Lauri Disput tensals) or both pennse to the first finite of the pennse of the p

312. The Nature of Light. Light a now committeed to be an electrowe gar so phe samenon one to a periodic variation in the energy given off by remaining controls. The energy is transletted by a series of per stir changes that show all the characters of ordinary wave phonogers. The light waves. as they are our meant causa, presess certain shirt wave roughs that are of the correct magnitude to affect the order nerves. On or stonar waves with league or shorter wave longths become the same class of phenomena. In modernely beyond the violet end of the violet spectrum is one dis so-collect "ultrav. ie 'waves with still shorier wave-longite an, on bevone these we have the Asrasa and the "guernor rays proceed by radium Of the waster having greater lengths that those of light waves we have the waves the give rate to the sensation of here and the Herezian waves used in wireless. An of these vibrations, while curving energy asily at high wave-lengths, belong to the name water of phe, and a much box to scare laws. The proportion that the sector of the series which produces the effect of hight beaute of the whole may be a mangly she we wrete we say that for busing where light is broken up into a spectrum a variability in this then considered to be excepted on a ber end so as to include all known electrotonguete waves the entire spectrum would be over five author actes to beight

The transmission of light through interstellar space, through heads and transparent solds, has for some time been explained by the assumption that a medium, railed the auministrous at a per a sold space arguing the intermonent ar space of nateria, bodies. In this medium, the vibrations of light waves are assumed to take place. For the purposes of the present work, however, it is an accessary to consider closely the exact mature of light or the mode of its transmission. It will assist greatly, however, in obtaining a dieuristic of the behavior of light in trystals if we assume that ag, I waves are use channels in nature and consist of periodic vibrations or oscillations it an all

prevading other

313. Wave-motion in General — A furnitar example of wave-motion
a given by the senes of concentral waves which on a surface of smooth water
go out from a center of disturbance, as the propt where a public has been
dropped in. These surface-waves are propagated by a motion of the water-

particles which is transcess to the direction in which the waves themselves travel, the notion a given from each particle to the next adjoining and so in This the particles of water at any one spot oscillate up and down," while the wave moves on as a circular ridge of water of constantly increasing diameter but of diminishing height. The ridge is followed by a value, indeed but a tagether properly constitute a wave in the physical sense. This compound wave is followed by another wave and another, until the original impulse has exhausted itself.

Another form or k,a i of wave-motion is illustrated by the sound-waves which in the free air trivel outward from a sonerous body in the form of concentric spheres. Here the antial motion of the layers of air is forward and each that is, in the direction of propagation of the sound and the till set of the counsier of this impulse from our ayer to the next is to give reso alternates to a condensed at i carefied shell of air, which together constitute a sone bwave and which expand in spherical waves of constantly decreasing tatens a size the most of air set in the real continually increased. Sound-works and the air continually increased. Sound-works and the air continually increased at a rate of 1120 feet per second at ordinary temperatures.

314. It is important to understand that in both the cases mentioned has nevery cose of free wave-motion, each point on a given wave may be considered as a senter of dist irbance from which a system of new waves tend to go eat. There in first I discover case ordinary destroy each other except so far as the onward progression of the wave as a whole is concerned. This is further the cases and the etrated in its application to light-waves (Art. 316 and Figs. 126, 126).

It general, therefore a given wave is to be considered as the resultant of all these are for enveroperties. If, however a wave encounters in obstacle a its para, as a narrow opening no, one barrow in conparason with the length of he wavel or a sharp refer then the fact just mentioned explains how the waves stem to be. I about the histories, once new waves start from their as centers. This principle has an important application in the case of light-waves, explains as the physicanics of diffraction. Art. 337,

\$16 % I meether case of wave-outton may be curretoned, more the parlies of a helpth a range a series apart ensure of ght phenomena. If a long rape activated at sinence be grapped at the short a set that a difficulty of the highest as well as ensure to a long
a range in one case a case of the other a trough such by the very quarter to the
other at one has constant as a second of the second that is, it was if twent
to a long a wave, I will return as a trought of past us the wave class rap help too er long
meanth are made attricted that wave is need force the sign of the second of t

est at the parties of the party of the party of the country we produce the country were the result of the party of the par

Figure v. I have a the reperhe analytic beneather a some contains a trapal, and or a house is a converted of matter any waves will appear took that one he countries a of the article will be seen to a new roughty be and of the average vibrations by which the waves of openingly polar and input are proposed to what the former case represents the vibrations of waves of what we consider polar reality polaries.

<sup>&</sup>quot; "trickly speaking, the path of each particle approximates caredy to a circle."

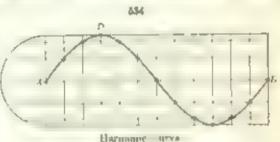
All three cases of waves obtained with a rope deserve to be carefully considered and studied by experiment or to sake of the assetance day give to an understanding of the compact themselves of light-waves.

316. Light-waves. In the discussion that follows, in order to make the explanations simpler and clourer, light-waves have been treated as if they consisted of need unjust distorbingers in a material measure called the other

The vibrations in the other caused by the transmission of a light-wave take place in directions transverse to the direction of the movement of the wave. These oscillations have the following characters. When an either particle is set vibrating a moves from a sorginal position with gradually decreasing velocity until the position of dismanship desplacement is centred. Then with gradually increasing velocity if returns to its original position and on so it is moving without free on it will continue in the same direction on pass this point. Its velocity with their again character in the first swing, when it will start back on the course and repeat the social till first swing, when it will start back on the course and repeat the social till. The vary, is velocity of such an oscillation would be he such as that shown by a particle moving around a circle with intermispeed if the particle was closered to a direct on type plane of the circle. It after these conditions the particle would appear to move forward and backward along a size give line with constantly changing velocity. Such a particle scalled scape have not notion.

the in this of the other particle is communicated to most re and so on each in order falling a still bound in the tant of its oscillation. Conse-

quently, while the individial particles move only hack and forth in the same line the wave disturbance moves forward. If, at a given instant of time, the positions of successive particles in their oscillations are plotted, a curve at h. as shown in Fig. 344 and he formed. Such a curve of Stromb as a h. resome



curve. The ose listory mot on of the particles to a light-wave is called a periodic material effects the treatment for passengent of a particle from its original post on fires is called the ampituate of one wave distance (\*\*D\*\* P.g. 334, \*\*The phase of a particle at a given instant is its position in the vibration and the discussion in which it is they mg.

The distance between any particle and the next which is it is like position—is of ake phase, as A and B—is the wave-seagth—and the time required for an completed inevenient is the time of viciniti, or inbration period. The wave-seve can therefore raivels onward the distance of the wave-ength in one vibration-period. The intensity of the light varies with the square of the amplitude of the vibration, and the color as explained in a later article, depends upon the length of the waves, the length of the violet waves is about one half the length of the red waves.

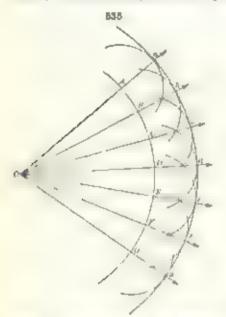
In ordinary tight the transverse vibrations are to be thought of as taking place in all planes about the Luc of propagation. In the above figure, vibra-

tions in one plane only are represented light that has only one direction of

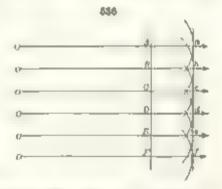
transverse wil ration is said to be plane-polarized.

Light-waves have a very man to length, only 0.000023 of an inch for the yellow softum flame and they mivel with enormous velocity 186,000 mines per second in a vacuum, thus light passes from the sun to the earth in about eight minutes. The vibration-period, or time of one oscillation, is consequently extremely hareful it is given by one ling the distance traveled by light in one second by the number of waves include: \*

317 Wave-front. In an isotropic meaning, as are, water, or glass --that is, one in which light would be propagated in all direct one about a lumi-



the waves are aphenen in form. The waves are aphenen in form. The wavesfront is the continuous surface in this case apheneal, which it could not be a surface at particle, that comment of time. Obviously the curvature of the wavesfront domininhes as the distance from a source of light increases, and when the light comes



from an indefinitely great distance (as the sum) the wave-front becomes sensitly a place surface. Such waves are points called place scales. These cases are matriced by Figs 545 and 536. It big 45 he aimid as point is supposed to be O and he we simple by greatener it is obvious that the wave-treat, is ABC = O, a spherical fit is a soluble exactly the figure how, as briefly at find in  $A \sim 314$ , the resultant if all the priviting amprises wheet go out from the successive points as A = O etc., as centeral forms a new wave-front, the A = O constitute with ABC = O. In Fig. 546 the luminous toxives supposed to be a lagrent distance, so that the wave-

The account of the transcatch is executed at which light travels the mountity of a brutom or frequency of give as a second man frequency of a give as a second from most result of a second. The extreme brush is the stand of a the respect to a passage of a single wave of the extra and man personals for the stand of a second that one eight before religions to the account is a visity enabler party a second is a second to a visity enabler party a second to a second of the whost of historic time. The beaute of Matter and Lucatricity. p. 157

front AB . F is a plane at rface. Here also he applythad unpulses from A B etc. unite to form the wave-front ab | f par diel to All

318. Light-ray. The starty of aght pher mother at, in commit cases. facilitated by the conception of a gent out a to come from the amazona point to the wave-front or a whose direction or one so us to represent that of the wave teelf. It Fig. 53.1 (14, (16, etc. are diverging light-rays, and in Fig. 536 OA, OR, ste are paradel light-rays. In both here exes, where the medium is escenarious to be us to pic, the light ray is normal to the wavefrom This societal by to as he that the ight-ways moves moved in a

direction normal to the wave-front.

It must be understood that he "aght-ray" has no real existence and a to be taken only us a convenient met not of representing by direct on of metion of the night-ways war or vitying count one. It as set in as a, proprate means teg. He wood waster the correct of the wave-in it is alread for example I from sering a place surface it is made sharply convex then the light rays, at true par let, are said to be to de to livers. Again of the convex wave-front is made plane, this deverging again tax a are then said to be

made paradel 319. Wave-length, Color White Light Notwither a ring the very

small length of the eaves of git they can a mean of a a great processed The votes part of the waves go by and from a ord and accordingly body he the give or curbons of an electric are agon, they be all an a good of waves of widely varying lengths. They are nife red waves whose leagth is 0.0007604 mm (alsort as not of an meh) and waves we see ength consent y dramship without break through the crarge veltor green, and his to the re et, whose in mean lergth outst stust per or item tof the fifth first. The sair bol corner by usual for the wave-ling to of hight or headala, he The course tight a conjugacy said to make, apost to act wronger and was been sween of large. This is not were true wever, because on a the vesicus of light, russ is hitle med to a logic which it is a recong while the variety period remains gone or right it can be a second in he was paragraph of eight of the solve eacher in using others in I flower, treshe it as to refer rather the frequency with which it, highton was reselvition year at experiment the color section of a strang servence in promitive by the order the person to the result of the state of the state of the The of mentalment in the way of corresponded to comply a contract to the a negret term (the legit with a solito specifical are only appraising

this correspond of two sets of war reach slight a different larger a encerflood of white right is a limited by the words from the real to the vi et echip toge her tallia est a militareously for as reason a lacco of

plate an at a temperature of 1500° C maps is " a nee he."

The transfer of from the subsection and, where such as electric at which or the all using per communities are langer cover which do not affect the eye one which, like the light waves, pro- jee of caffeet of said in heat when received that an absorbing surface as one of at pooles. There are also, par section y in the radiate a from the sun, waves shorter than the red of which

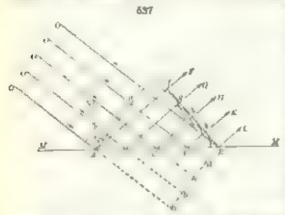
The wave lengt, aght a continue, given a dispersion, in the the of a mile tracted the year and and the continue of the plant. See a sale part of the plant is the continue of 161 pp lane, 500 pp green, 558 pp vehow, 623 pp orange "67 pp red.

also do not affect the eye. The former are called infra-red, the latter idira-

The brightness of ight depends upon the amplitude of its vibrati as and

varies on the as the square of the distance

320 Complementary Colors The scheation of white light mentioned above is also of camed when to a given color that is right water of given



Perchange it diggeraphy store in otherso-ested compleasantery color. Thus certain shades of pick and green combaned, as by the rapid rotation of a pard on which the colors form segments. to chare the divided of white Bitte and yellow of certain Baingage are filme restrict Plantieton, For every shade of color in the spectrum there is not that the completions turn to it in the sense here tenned the street partici directions of companient tery colors a gis in by the

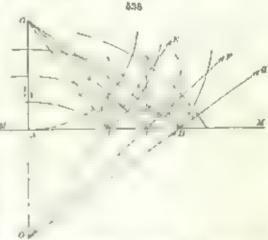
exite that it were one of crystals in the arrived light, is notee expent to

321. Reflection. When light wavew come to the best any which we in the price under modifier as a surface of water of gloss in a r.

tas ere, or general in part reflected or returned back into the first modium.

The reflection of lightwaves is illustrated by bus 537 and 538. In Fig. 537. MW is the reflecting surface - here a plune surface - and the light-waves have Bld a supply rout there. in other words, the light- " rays (OA, Ob, ote.) are paralinl. It is obvious that the wave-front meets the gurthe tree of a difference ms is trem point to point to for a ness profite the r be resurded as the centers of aca waveways one which ummeded would be prop-

unimposed would be propagated on two and as a given metal two did have traveled through distances equal to be interested. But the Herri is common that gent with to the circular tree orders and these rain from A(B), etc. represents the circular tree of the new or reliable, where from B, it geometrically the right of AE is equal to FEA, or the incident and reflected uncestically.



fronts make equal angles with the reflecting surface. If AA is a normal at A, the angle AA V caused the angle A includes a separate AA, the angle of reflection. Hence the laminar case

The angle of owner we is equal to the angle of rediction

Lurthermore, the at which and reflected rays both be not se same place.

such the normal to the returning our are

In Fig. 48, where the air boos per period O the waves gory set from a will meet the pame curror MM that at the point A at any A of pendagons B, C B, cir. Liftmer away to be right, and A A Here does a start to show that A is a matter process. There is a very degree of A B C, C C in set logs there give rose to a series of referred a very of set of each C at C and C are equally great from B M increases of a neutral to in relative C A = C A.

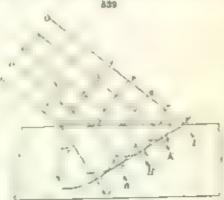
If the police agree those is not place but for exactly a service surface on that disqueen average parche of the rate of a large of the case through

the wave front after retire um, but we came law since home to

The properties of the reflected following to the about t

he good git

322. Refraction. When highly passes from he measure in the absence of the process in the transition of the crosse of decrease in the transition of the constitution of the process of the property of the process with a price was selfond to be not form in Fig. 332. It is the where the light rives 0.4. OH ever any personal propose for example, the a



de Seppose for example the algebraic part falles view out as Alade passes to a all obtained as guess its when to be a view two transfers great as it was nother or and suppose to said and it of the be plane. As the moment that the color of the late of the late of the moment that the color of the late of th

to E, the ray O-A will have advanced in the glass a distance equal to fe-E, or to some pend on an are having cass distance as a radius A f. In the same way during the time may O-E passes from the point p to E, may O-Bwall have traveled in the gases the distance B-g equal to 1p-E In this way ares may be trawn about each one of the points 4, B, C, etc. and the post-1 st. of the new wave-front in the glass determined by their common tangent. Fixing. It is seen that there is a change of direction in the wave-front, or Afterwise states, in the hgld ray, the magnitude of which depends on the ratio between the light-velocities in the two media, and, as discussed liter, also upon the wave-length of the light-ray is here said to be broken or refracted, and for a medium like glass, optically denser than our (i.e., with a lower value of the nght-velocity the refraction is fowned the perpendicular with the angle of refraction, r, smaller than the angle of their dence, a. In the opposite case, when light passes into an optically rarer medium - the refraction is away from the perpendicular and the angle of refeact, in is larger than that of invidence (Art. 328,

323 Refractive index.—it is obvious from the figure that whatever the direction of the wave-front—that is, of the light-rays—relatively to the given surface, the ratio of eE to Af, which determines the direction of the new wave-front (i.e., the direction of a refracted ray, AF) is constant. This ratio is equal to  $\frac{V}{r}$  where V is the value of the light-velocity for the first medium (here air) and r for the second (as glass—This constant ratio is commonly represented by n and is known as the rates of refraction—Therefore

$$n = \frac{eE}{Af}$$

In Fig. 539, by construction,

Also, 
$$\angle eAE = \angle i$$
 and  $\angle AEf = \angle e$ ,  $AE = \sin i$  and  $AE = \sin r$ .

Thorsfore,

$$\sup_{BB} \frac{eE}{e} = \frac{eE}{A\bar{E}} = \frac{eE}{A\bar{f}} = \eta_*$$

The law of refraction then is given by the expression,  $n = \frac{\sin z}{\sin z}$ , or may be formulated as follows:

The same of the angle of suculance bears a constant ratio to the same of the angle of refraction.

In the case of light passing from air into crown glass this ratio is found to be sand = 1.608, and thus number consequently gives the value of the refractive order, or a, for this kind of gases.\*

<sup>\*</sup>Strictly speaking the codes of refered on of the other to a varying as taken as mady, but a need at his pressure of the present of reference is for air = 1,0000, the is few of any masstance as obtained by comparison with that of air.

The above relation had structor any wave-system of given wave-length in passing from one medium in a so ther, whatever the wave-front or shape of the breathing surface. In Fig. 340 the sum none point is at O and P can be readily so with that the new wave-front propagated in the second medium of greater optical density has a different curvature and corresponding to this a center at O (where  $\frac{OA}{OA} = \frac{V}{V}$ ). Here the incident rays OB OC, are refracted at B and C, the corresponding refracted rays being BE and CF for this case also the relation holds.

good,  

$$n = \frac{\sin i}{\sin r} = \frac{\sin r}{\sin r}, \text{ etc.}$$

If the bounding surface a not plane but curved as in lenses, there is a change in the curvature of the wave-front in the second medium

but the simple law,  $n = \frac{S(0.1)}{\sin \tau}$ , holds true here also, so long as the neutron is asstropic.

The relation between wavelength and refractive in lex is specien

of in Art 333

324. Relation of Refractive Index to Light-velocity The Liscussion of the preceding writely stows that if n is the refrictive index if a given substance for waves of a certain tength referred to air, I the velocity in our and r use velocity in the given medium, then

For two media whose indices are n, and or respectively, D consequently fol-

$$\frac{r_1}{r_{12}} = \frac{r_2}{r_2}$$

Therefore—The indices of refraction of the given med o for a certain wavelength are inversely propert may to their remove right sets dus

In other words of the velocity of light thear is taken as equal to I and the velocity of the same light is found to be one-half as great when passing through a given substance, the index of refraction of the substance when reference that is a 10 will a requal to 20

326. Principal Refractive Indices — The refractive index has as stated, a constant value for every substance, referred, as is as in. In air or it may be so a vacuum). In regard to send measure it is extracted from Art. 323 on will be further expended before that these which are issue poor at a ungle value substances and crystals of the isometric system, can have but a single value.

of this index. Crystals of the tetragonal and beargonal systems have as later expanded two principal refractive indices  $\omega$  and c corresponding to the velocities of ight having certain definite injections of vibration. In their, and orthort some mentions and trichine crystals have similarly tree principal with est  $a, b, \gamma$ . In the latter cases of so-called amount pic media, the mean refractive index is taken as the arithmetical mean, namely  $\frac{2a}{3} + \epsilon$ 

326 Effect of Index of Refraction upon Luster, etc. The lester and general appearance of a transparent access to the leptered largely upon to refractive it fix. I in that there is present a spect of the roneral cryol to by it eats to write it a special possible to read a local to the substance is she to its low index of refraction in the roll of the special transparent to go in a solution. It is quite it will disappear and apparently go into a direct like in the water because its index of refraction in about 1.34 is near that of water 1.550. The light will trave, we appear and a present the as the last the water and entered pointly. If i to restore a present is at the exchange between the two control of the refraction of the idea of the refraction of the idea of the parently of the parently of the parently.

Satisfances having in attribute a last mater of refreshon have an appearance which is highly being and who have govern between the an advantation of the last of auster may be set emperorated by examining appearance of the set of auster may be set emperorated by examining appearance of the set of austernation is a more of consequence of 198. They have a likes and culture's sometimes of as a more operations which is not presented a nature of a low retrainer of new foreground example, specification for the first of an interpretation for the first of an interpretation for the first of an interpretation of the first of an interpretation for the first of the sum to make a strong description of a strong descriptions of a strong buster.

he was given a set of common to words arranged according to their indices for raction. For maintains there has been of a set our existent the average value, as defined in the preventing article is given here.

Waster	1 335	Jan a	. 723
Phone to	1 5 5	I	. 750
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Barrie	1 (4)	t ipnir	2 449
Or parde	1 685	Cubabar	2 909

All Relations between Chemical Composition, Density, and Refractive Index. That det note is a source to composition of a solection of a solec

328. Total Reflection Critical Angle. In regard to the principle struction of Art 323 at 1 expressed by the equation  $n = \frac{800 \text{ T}}{800 \text{ T}}$ , two points are to be noted. First, if the angle n = 0 then on n = 0, and  $n \geq 1$  this also  $n \geq 0$ , another words, when the ray of light as  $n \geq 1$  Fig. 5:00 considers with the perpendicular, no change of direct in askes pace, he ray proceeds onwhere  $n \geq 1$  and the second most are without excaton, but with a change of velocity.

Again, if the angle  $r=90^\circ$ , then sin r=1, and the equation above becomes  $n=\frac{1}{\sin r}$  or ain  $r=\frac{1}{n}$ . As a has a fixed value for every substance, it is obvious that there will also be a corresponding value of the angle r for the case mentioned. From the above table it is seen that for water, sin  $r=\frac{1}{1.335}$  and  $r=48^\circ 31^\circ$ ; for crown glass n=1.005n, sin  $r=\frac{1}{1.608}$  and  $r=38^\circ 27'$ ; for them and, sin  $r=\frac{1}{1.5}$  and  $r=24^\circ 25'$ 

This fact, that for each substance at a particular value of the angle r the angle r becomes equal to  $90^\circ$  Las at important bearing on the behavior of light when r is passing from an optically deaser into an optically rarrow state. In Fig. 541 we may assume that light-mays coming from various three missinger the surface between a black of glass and the air of the point A. Light trivialing us by the path O. I will pass out into the air of the point A. Light trivialing us by the path O. I will pass out into the air without a change in the direction last with an increase in its velocity. If it emerges from the glass at any other angle than  $90^\circ$  the may on entering the air will be best away from the perpendicular and the angle of deviation will vary with the light which the ray touched the sortage and with the ray of refraction of the glass. The same saw holds true in this case as in the case of a ray entering from the mir, except that the formula now reads  $n = \frac{\sin r}{\sin r}$ , where r = the angle the ray in air makes with the normal to the surface and r = the angle that the ray

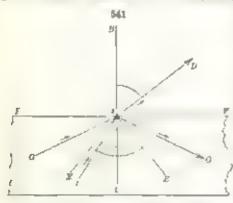
makes within the glass to the same Lornal . It hig 54) the ray (" A will pass

Phil. Trans., 183, 317, 1863.

West Ann 9, 94 1880 West Ann 11, 70, 1880

<sup>12. 145, 259, 1907</sup> 

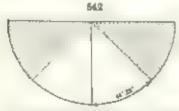
cut into the air along the ane A D. But the angle i for the ray E A 39° 27′ and, as shown in the preceding paragraph for glass, where n=1 608 the angle r in the air wall be 90° and the ray wall trave, along the surface of the glass at the direction A F. Consequently not ray such as  $G \cap A$ , which means

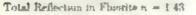


the start are of the glass of an angle greater than 38° 27° who is unable to pass out into the air and will suffer total reflection at the surface, passing back into the glass in the direction A-G', with angle OAG = angle

The phenomenon of total reifection is taken advantage of in the cutting of gem stones. According to common practice such a stone is cut with a flat surface on top and with a number of inclined

facets on the bottom. The light that enters the stone from above is in a large measure totally reflected from the sleping places below and comes have to the eye through the stone. The abount of light reflected in this way and the consequent brunancy of the gene is reases with its index of refracts a Two stones out exact value one from hamond and the other perhaps, from quarts, which have very different appearances due to this difference in the amount of light totally reflected from the relevent three This principle is allustrated in Figs. 542 and 543. They respect cross sections of two terms spheres out one from therite and the other from diamond. It is assumed that tight from all direct has is focused on the center of the plane surnace of each normalitate. All the high this meets this surface at an angle greater.





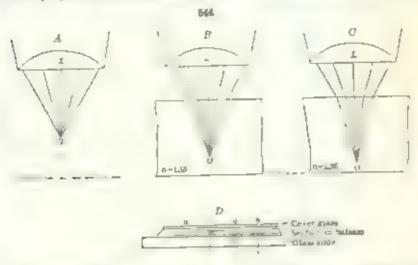


Tital Reflection in Diamond a = 242

than the critical angle for the numeral will be totally reflected back through the spherical surface. The smalled areas of the figures show the amount of light in each case that would be so reflected and centrly illustrate the optical difference between the two solistances.

329. Effect of Index of Refraction upon Microscopic Phenomena. — In the study of non-real tenegrally in this sections under the increaseope, variations in the interest of refractive give effects which are of importance. In Fig. 544 let it be assemed in L is the copie on least a compound increaseope and that the instrument is exactly focused upon a point O, Fig. 544 A. If

now we imagine that a section of some mineral of mean index of refraction is placed under the lens, (ig. 544 R) be pair 0 will new be in forms or as in big. 544 R, where the mineral is supposed a have a light undex of refraction the focus will be as 0. These the that with two sections if equal thickness and with the lens in the same pastion the oral deeper into the numeral of higher index of refraction. Consequently, when there are two interests in the same section, the inclusion a tage and the other show unlex of refraction of retraining, a creation of time in n = 1.95, the one having the higher index of refraction with apparently have the greater thickness and with appear to start up in rend above the surface of the numeral of lower undex. The apparent relief is furthermore augmented by other properties to be explained below.



In preparing that see rans of monerals or make for study with the papers. peopo the process in brust is to make first a fit surface upon the transfer of rock by granding it upon a parte supplied were some about to starface is their contented to a mean of a second of Canada bu sun and the remainer of the maceral is ground away until on y a thir han remains which in the heat mack sections is the entry data from in thickness. The section is fina wernhedded in bassar, makent 1.54 and over it a thin cover glass is and In the preparation of a season the surfaces up but polished hence from the nature of the abrustic treat must be putted and scratched and it is at be assumed that in cross sect to some a propertion would be somewhat as polyssented in Lig 541 D. When a thin section a examined under the purpose parthe light enters the sector man below has my twen referred une the interescope table by an increasing right. Referent these is the section of the have passed through a new trees, and through a signtly convergic ens Let it be assumed that he makers at a Fig 344 D granest it as a receiving index. The convergent light of oring the section will pass with arm if no refraction from the named into the baseon because their personne and see are nearly anke. Hence the roughness of the surface of the section is not

apparent and the nuneral appears as if pulsabout If there is a crack as at b. so much light penetraces I that it is scarcery a since when the convergent ons welene to the of sect but when the latter is I wered and expect my when the agains restricted by the ast of an instrumbraga itseried this field one soupe the the perty para of may of light we suffer some than reflect or about to ane of the creek and so make it white the other tend, if the that it it is a treath let frefrection there is the innumerator it was all over the section where the surfaces are so its and har the right will strict total reflect on a strength as to pass from the optically dense a mer, pto be rarely Here to an enjoyee of the section die to its grifely a selector v v v at This effect is no re projected if the convergent this is knowned The cracks that may exist in a monera, of high index of natural place is the without the fact there be not seen no mutita of two will firster if a mater. I had notes of refraction a craited ed in one of now of Fig. 544 Deferr will be on see along its cover eage when total reflection will take private language and the to be disk at 1 temper. The effect count that with the reast series aspect of the surface or , the apparent increase in thockneed as described to the precenting teather up to all tend to trade a nones, of but you of reference of the ton the second on relief I have offered north way, look with a notes of to all unique workers a large atout above, with the condensor dust acres, posterior par a vetrar .

330. Determination of the Indices of Refraction of Mineral Grains under the Microscope. The complete tours of the preceding article angle is the angle of internating the indices of retraction of national grains indice to an appear of internation of indices in the indices of retraction of indices and refraction of indices and indices in the analysis of the control of the control

purposes, we a their mainty I refraction below

Petroleum distillates	1 35 1 451
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large mental of the property of the second	1 Per L 555
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aron, militar the early of the five land see Miracle	5.740 (1.870)
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Her as we substances formed from instance I papering and	
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(ece Barth)	2-24 -2-78

Weight Methods of Pringulation Marine in Herenary p. 28. Mercia Jose Wash Arad S. S. J. Lara, M. weper Letters as one of Nonopolphe Marine, 1922, 1932, 1934, 45. Mar. Mar. 18. 18. 18.

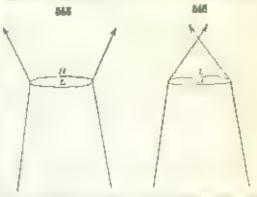
1 Harrington and Dogreer Am. Mon. 10, 45, 1931

The indices of refraction of the test liquids can be determined either by the use of the total refractionator or by filling a bollow glass prism with the liquid and using the methods employed with ordinary material prisms, see Art 332.

A series of these liq advahauld be proposed which for most purposes might conveniently show differences on be undices of the different liquids of 0.01 If a more exacting work sing for differences between the aid cas. If the members of the sories would be of advantage. If these are kept in well stoppered but as and are protected from the light they will show very little charge over considerable periods of these. It is advantage, however, to check their in account least once a year.

The nameral to be studied should be broken down in a uniform small grains 0.05 min is usually a good diameter, and then a few grains placed

A 1mm upon a wiss ah ie of lagar, with a known me in of refraction is then parced apon the grains and the whole covered with a thin cover glass. When a maneral grain is immersed in a hand of closely the same index of refereble to bees its sharpness of outline and if the runeral is colorless and the correspondence of the two indices exact it will quite disappear. Cortain tests, however, are comnone uses, to describe he retaine indices of the mate with proper cure can distin-

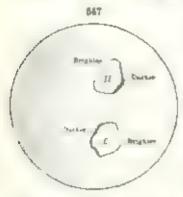


Horne uses, to describbe the first with low Refrest victors of the house to be a conserved to be a conserved to be a conserved to be a conserved to be a first the lapted which is discharge linear of how their received

gual differences as small as 0.01 or with proctace and especial care as small as 0.001. It have these tests the cun apper below the properties stage should be his erest dat if the inscriment has a sub-stage me upder gen, has should be partly cosed. I nder bese combined the other of the whit is reduced and only a sum pencil of high composed of no ray part left rays enters the section. Such the end grouns will usually be theme. In the process and sot somewhat her leases in their effect upon light. Let big. We represent a triners great during teel in this way when nattered in a place of higher makes of refraction. The agl terays as they pass from the punitre and the spher refracing I gold above will be bent away from the perpension, in In the opposite case big. 5to where the man of horse hed giver index the reverse will be true and the light-rays and be best to ward the perses deciliar This will produce in our case a brighter illumination of the wielers of the musers grain and in the other a brighter illuturation of its center difference in illimittation is, is swever, community so slight as to is certainly detected only with difficulty. The seconded Bicke Test a commonly used under these erreamstances. This consens at focusing upon the grain with a high powers bject vi and then slowly raising or lowering the imprescripe time The condenser iens baneath the microscope stage saward be lowered so that

the grains under observation he above its focal point. In the case illustrated by Fig. 545 when the time is russe, a narr whine of light will be seen to move outward from the min ral, while while the table is awered this line who In the case Hustrated in Fig. 546 the oppose of out the many if pres A. A convener rule to remember a that when the interocopy tube to raised the Books was now howard the material of higher refractive index and when the tube s craves, this me unt move toward the material of inner index This makes a very a tistar fory and quite dears to test for distal guisting differences a re-ractive indices. Son etimes two lines will appear moving in apposite directs us and it may be fallegal, to decide which is the Becke the le usages or crossed by I mering the condenser of decreus ng he aperture in the aris displacem. For the use of the Becke test in rock sections, see Art 331.

The test upon immeral grains immersed in a liquid may also be made by means of clayage Managarion.



An old pre-peopl of this may be obtained nest conveniently to placing a pence a finger or a piece of capillound between the reducting marris and the polarizer in such a way as a darken one had of the head of vision. The best results will be obtained by the use of an objective of medium magnifying power. When a military grain is viewed under these conditions it will be noted that one of its edges is more brightly illuminated tages the other. With the condenser lens lowered and mineral with a lower index of retraction than the agend the origin edge of the moveral wil or away from the shallow, with a if the materal has a higher rules than the legand the length edge will be on the side toward the shalow. These conditions are

presented in Fig. 347 where L and H represent grains with in ices respectyen lower and higher than the equal in which they are unnersed the concenser long a cuseo so that the matera gran will be below a focus, effects exactly apposite to these describes, above will be blies. It is made to test the apparatus used by observing mineral fragilitats of known indices

and tiking note of the effects prod ped

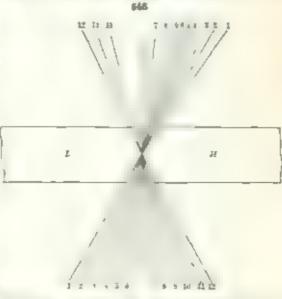
Commonly the 19 the need have a higher happerson that the monered to be tested. In other words the oraid will lave entirely. Ifferent reduces of refract on for red and to till elight. If the mater a should have an injex intermediate be usen these for red and blic light in the hour, the grain whot the manufest to oblique light will show colored sorders. With the conleaser tens a werest he edge of the mireral aset to the sandow was be expred an orange red what the edge away from the shadow will be take like number of to dispersion in the new lary, the lifterines between the indices for blue and red light a part too great this offect gives very cosely the refractive index of the pipera.

It should be pointed as here that ad minerals except these of the termetric two cin, st in different in lines of refricult to depending upon the crisical girect, a n when as ugar is so on, no while passing brough the namenal. Consequently unorthinated grains of a mineral, othess it belongs to the teametric

system will show a variation in the refractive indices depending upon their position on the shifts community it is prescribe to the critical orientation of a grain due to so at significant elevation or a trainer and so found the invites (it come particular greats direction by ordinary as that can be determined as as mean mass; a paraet it of he hands.)

331. The Hecke Test in Rock Sections. The becke test can be often used in a rick section to tetermine the regards indicated retraction of two I florer contract phase should be nearly section in index to give clear results. The position of this

plane can be retermined Lis frie issing on the statement of the section and then he can in proscope the is lawerer, is a whatter in but his possit of all the d viding her between the the interfaction tendences tionary or moves. It is remains star mark or moving only, at the this Clay I the Dilator of vertical or nearly so Uniter those corde ups assume that the cont of | g r entering from below a for seed at both O. Fig. 508 of high on the divinity page at tween I mane but with tower index so I H is 6trac with higher in lex The ogla rave ' f passthe as they to term a Inthera - I lower in ex-



In the filling control of the notation of all emerge from the greaten on the site of H. On the other and, and T, is a term of the pass from H to I with the particles across the analysis of the site of the will be not to reflected at I. If there is a site of H. H with the reflected at I. If the research is then I. If the rise also when the turn I, the increase is a traced in Beach how will be seen in wing toward the ring of the site of the order of the ring of the site of the site of the order of the site of the order of the site of the site of the site of the order of the site o

332. Dispersion Methods. Various melt als there been heaved for the determinate in a tribles of refraction with the uncrescope which depend upon the order to a range in temperature. By the mans the possible to vary the index of the heavifunction. By the mans the possible to vary the index of the heavifunction of that is a respect to a respect to the possible to make determinate in that are presented to a 1001. The data with ares of the methods are that they require more apparatus

and greater skill a man p in on

By using a memochromatic dhuminator, the index of a given mineral may

be determined for a certain wave-ingth of light when immersed in a certain hard. The infection feature in of that particular hard for several waves by give of light length on yikh was it is possible to establish the infex of rate of it is then inner hard by the wave engine found, a light. In practice the same innerse of hid to immersed in two or three inference liquids in order to cheek the results.

Amount to the relex of a section as all may also be predicted by a change in its temperature. A construction which we terrify a surface persuage residence is a construction of the stage of the congruence and the majority great residence of the congruence are to a congruence of the congruence are to a congruence of the congruence are of the stage of the congruence are of the stage of the congruence of the stage of th

A serious of these two in code are we us be let to dispersion me of an interest to be the trace of the find decreases with a context of the trace of the find decreases with a context of the trace of t

ale to the ell and man and the law to be

333. Determination of the index of Refraction by Means of Prisms or Plates. It of an index of refraction by its index of refraction of its index of the index of refraction of its index of the index of the index of the index of its index of

I The Method of Proper contact to the contact of all athough not the one manage of a variable color of an exact one of the one and the final and the second of the color of the formula processors for a king the color of the one of the color of the color

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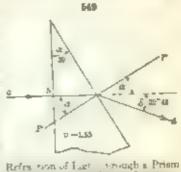
This angle should be small enough so that the light may pass freely through he prior or best effect by the prior to a sit for passes to a the out the prior tenses with a rate matter of a 1441 the prior angle mast to see that 11 2 from this capacity of the enough passes that 11 2 from this capacity of the enough passes that 12 from this capacity of the enough passes that the prior of the enough passes that the prior of the prior of 24 24 the three there has I means to the course of a color of the prior of th

Little 549 represent the cross sect in class 1 prior Lot a brepresent a ray found a raking the face of the prior at six an adence. It was suffer

no deviation in its path on entering the prism but will proceed with somewhat diminished velocity until it reaches a. In passing out of the prism at this

point, from a denser to a rarer medium, the right will be deflected away from the normal to the surface, P(P), making a domation  $\delta$  in the circum cod. The data necessary for the calculation of the index of retriction in fer these conditions in the pasts of the light  $\delta$ . It is easilised in the pasts of the light  $\delta$ . It is easilised from the figure that  $\alpha$  and  $\alpha$  are equal for they are both pasts of right-angled trainingles having the ingle  $\delta P'c$  in common, and  $\alpha'$  is equal to  $\alpha$  because they are opposite ingles. The angle of newdence, as defined in Art. 322, is equal to  $\alpha + \delta$  and the angle of refraction is total to  $\alpha$ . There is

the usual formula  $\frac{\sin x}{\sin x} = n$  becomes here  $\frac{\sin x}{\sin x}$ 

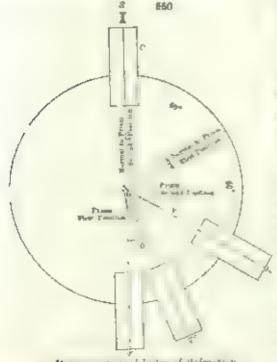


Refer von of Liet torough a Prism Method of Despend mar in mende

sin a = n. In order to make a determination of the undex

of retrieved in therefore it is processors to measure these two ingless o and i

The press is nounted on a one-circ c reflect on go at the ciet and its argie of the work in the same way as an angle upon a crystal. The distribution is then adapted to be uses of a refract-meter For this purpose it is necessary to now that the beloscope and vertien are both fastered to the otter mm of the astrument and move togesher. It graft ated circle home claimed the telescope other as first massed to the presiden T Cig São so that t a rays from the collamater tube C passibit the edge of the productive the Laht sur to for on the vertieat ems-hair of the telper pe The inter cities has ing company the telescope is pest moved through an are of exactly 60° to position To and then c unpoi Next the

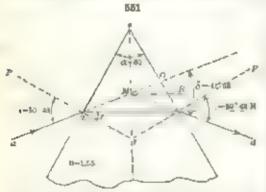


Determination of Index of Refraction. Method at Perpe on mar in ourse

prison is turned to the first post out so that the ight from ( is reflected from its right-hand face and the signal a time on the cross-hait of T - 10

this position the normal, N, to the priem face, must bisect the angle between the axes of C and T'. The prism is now turned through at angle of exactly 10° to its second position which brings the normal A exactly to bine with the axis of the columnor tube. When this has been accomplished the graduated circle is seen rely clamped. The telescope may now be unclamped and moved with at altering the position of the prism, and streamhere between T' and T' is position. T' will be found where the refracted ray fails on the cross-hair of the telescope. The movement of the telescope from the positions T' back to T' gives the angle of deviation or \(\delta\_i\) of the light-ray that has been refracted by the prism. In practice it is well to repeat the measurements high of and \(\delta\_i\) several times and to go through all the operations of seriting the positions of the prism and telescope. If white light is used for contraction the refracted ray seen if T'' will appear as a tarrow spectrom. To make an exact determination a monochromatic light sodium light is best) must be employed.

 The Method of Minimum Deviation — This is the method that is most generally employed for determining indices of refraction by the use of prisms.



It depends upon the principle that when a beam of light. abed. Fig. 551, traverses a prism in such a way that the angles ; and i' are count the beam suffers the manuagn amount of deviation in its path of any bosoble course through the prism. This fact may be proven empirically by experimenta ion on the refractometer. In order to make a determination the angle a of the pristo le first mess red on the as biometer. The angle of the prem with the method

may be considerably larger than when the motion of perpent calar that dence is used. The do evaluation will increase in accuracy as the angle of the onam at proact es us maximum pesset e sizo. The prism is then signed with the edge to the left about as in the position about in Fig 652 the teleare se unclatament up I moved until the refracter, ray appears in r. Now, turn the cen me post with the prism on it tow ret the left and follow he signal with the telescope. The post on of mammin devuntion is soon reserved. when, on throing the prism, the signal seems to minism state nary for a moment and then makes were to the right, no matter in which direct in the prising as turned. Air the price or is needed to determine exactly the poor tion of in months, tevastics as the measurement should be made in a transfer When the telescope a property placed a margon. As graduated circle is comped and the telescope turned until the direct agent from the columntor the is fixed upon the vertical cross-batt. The angle between these two prostions of the telescope is the same as the angle of deviation, or & The formula for m king the necessity calculation from these measurements fellows very senior it as a confurmer if high 551 and 549. It may be anarrase, that Fig. 551 is composed of two prisms like Fig. of b places, back to back. This results in doubling the angles or and a so that the formula new becomes

$$n = \frac{\sin \frac{1}{2}(\alpha + \delta)}{\sin \frac{1}{2}\alpha}.$$

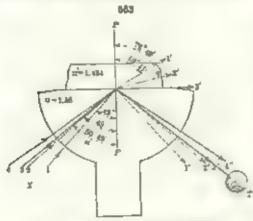
The Method of Total Reflection -This method is based upon the principle that light cannot a ways pass from an optically dense into an optically rarer medium but at a certain angle, known as the critical angle, wit suffer total reflection. The critical angle for any substance varies with the index of refraction of that substance as explained in Art 328. Consequently if we can measure this critical angle we can calculate the ardea of refraction of the substance. This method is particularly useful because the mengarement can be made upon a single polished surface, which may be quite small in area. This measurement is made by means of an instrument, known as the Total Refractometer, a description of which will be found in Art 359 The essertial feature of this instrument is a Concessor Tobe
Tobe

Incident
Ray

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Ray

Determination of Index of Refraction Method of Manuscan Deviation

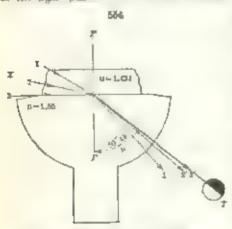
hemsphere of glass with a known, high index of refraction. The upper surface of the hemsphere is plane and should be accurately adjusted in a horizontal position. The mineral



Determination of Index of Refraction Mathod of Total Reflection, 1

zontal position. The mineral to be tested may be of any shape provided that some surface upon it has been ground plane and polished. A drop of some liquid of high index of refraction is placed between the surface of the ginss hemisphere and the flat surface of the mineral. This serves to unite the two substances and dispel the thin layer of air that would otherwise separate them. The liquid should have on index of refraction intermediate between that of the glass and that of the mineral. As the liquid ites between the two sittstances in the form of a thin with parallel surfaces fibro

whatever optical effect it has upon the light as it enters will be behaved by the opposite effect as the light leaves the film. So the presence of the film of liquid can be ignored. Fig. 553 represents a cross section of such a heighsphere with a numeral plate resting upon it. Let it be now supposed that by means of a mirror a beam of monochromatic light is thrown upon the apparatus from the direction of A. Rays I and 2 will suffer partial refraction at the dividing plane between the glass and the mineral to rays I and 2 and also partial reflection to rays I' and 2". Ray 3 strikes the mineral at the critical angle for the confination of the glass and mineral and will in part to refracted at a 90 angle and energe as my 3", has graining the surface of the Ferrigiller. The greater part of my 3 will however be reflected as ray 3". Boyond this point in the ight must be totally reflected, that I to 4". If the optical cost of these period mow brought to the lifett, in 3, what appears to be a markest shad with a present of the first of the surface will be distributed by the turnion of all rays begond the set of the critical angle while the there are, will be that neity darker since here a considerable amount of the age. Assessed out into the immera. The angle between the position of



Determ into a Index of Refraction Mathematical Para Reflection, II

the shaw wand the number to the surface of the hemasphere, a. F.g. 558 will be the critical angle for the combination of glass and mun-As the undex of referet on of the gines is known it is possible to extoulate what the indux of refruetop of the mineral moist be. If the mineral plate is transpurent erough so that light may pass through it into the glass herulaphere another method of Illumination may be used, as illustrated in Fig. 554. The reflecting mirror as so arranged that actight econes from the direction X. Rays I and 2 will be refracted! I and 2 and 3 which its, graves the surface to Beyond this point po gett will pass out the tempsplace and

a tensorpe placed with its uchs mong the lant 3 wal and with the discussion will be consider between the light and dark perturns of the held by the method of illumination, is much atmager that by the one first described. The coscope is so placed that the law of the sharons exactly disclosure any a between the four half cross-barrs of the expired. The trescape is actual all to a graduated circle from which the arguments of disclosured by and the second circle from which the arguments giving be in loss of refrection somes and right the different possible values of particles and actual companies by the covertor to a curve possible values of particles at a gardeness by the covertor to a curve possible values of particles at a gardeness of the heat sphere and the value of a form a possible value for a refraction of the glass of the heat sphere and the value of a form a possible value and any place. It is a considered the curve of a sign measured, then the index of refraction of the near sphere and the curves of again measured, then the index of refraction of the near sphere and the curves of again measured, then the index of refraction of the near sphere and the curves of again measured, then the index of refraction of the near sphere and the curves of again measured.

<sup>\*</sup>The harvation of this formula frames. From the origins we for the order of refraction we have, relating of tight in mineral aim f = n. But when the order I angle is

334. Dispersion — Thus far the change in direction which light suffers in the neutron and reference has a one been consistered. It is tartled the the interest of retraction differs for aght is different wave engiles, the ingreater for the interior red. In a new ence of this fact, if one, it is har to passed the aght a prism, is in Fig. 551, it will be then be refracted by the passed through a present or be separated into its companion course the graining the prismage spectrum.

This ventures for the different eriors depends directly upon their reversing his the red waves are longer, their transversa in retions are so the red may be shown to fin ow from this that they suffer less entire of veneral crementing the new medium than the vice waves which are directly under veneral transverse subgation is greater. Hence the retriction dies for a given a betance is greater for blue can for red light. The following one values of the refrictive matees for diamond on grained by Schrau.

2-40845 red (lithum flame). 2-41723 yallow (sodium flame) 2-42549 green (thallaum flame)

386. Spectroscope. The instrument most commonly used for the analysis of the left by dispersed as femaliar to as a trapector per first are a name of varieties of spectroscopes made. Surpose to a action season a grass prism mounted of the content of the instrument of the values poining away from a little light from the given source is received through a time shi in the content of one take and mode to fall as a primary we that so, as a pencil of parallel rays, appointed and mode to fall as a primary we that so, as a pencil of parallel rays, appointed the primary at the content is showed through by its passage through the primary and the spectrum produced is showed through a suitable telescope of the control by specimal produced

If we light from an increasescent soft which is which it the 319) is viewed through the spectroscope, the complete trained of whors of the espectrum is seen from the real through the orning, velow grown plue to the view. If, however, the light from an increase the per is expended, as found to give a spectrum consisting of bright hors, or a raise only and these in a definite position characteristic of a set the veltow has doubt the extension vapor, the more complex series of new and caude, red, cellow in a

$$\frac{1}{n} = \min_{n \in \mathbb{N}} n e^{n} = \lim_{n \to \infty} n$$

$$\frac{1}{n^{n}} = \frac{n^{n}}{n} \quad \text{are } n = \min_{n \in \mathbb{N}} n \times n^{n}.$$

reaches the GC and make the figure of the many admits the and have

1 reductive that in mineral or rescribed out to the normal to the many the the many to the highly referred by gloss of the homosphere whose referred to the figure of the homosphere whose referred to the figure that have a the case to the fight attendant, reducing all other to gloss the figure of the fight attendant, reducing the fight in mineral win 60° measured an instrainment. By note that the processing of highly in mineral and the fight in the course of highly in mineral and the fight in the becomes

green, characteristic of harrim, the midutude of hight lines due to tron

vapor in the ease of t electry are said a on

The manner range of the specimen of the specimecope so much that can be seen permanent the specimen of the specimen of this corresponding to proceed a case was except to a case which it is a case was except to a case wa

330. Absorption. Of the given on it upon the writers of a new meet, in the vive part reflected Art 321 at 1 per trader ted and refracted Art 322, but it geter a part a new hards, at the original of part and a representation of the original of the second of the part of the part of the second of the part of the part of the second of the part of the par

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offert of this particular state of mel

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mass of the sun.

337 Diffraction. When inconstruct a night a male topose through a term who are a time of order to the properties of the form a find the properties of a time to the term of the properties of the form of the first of the properties of the form of the first of the contract of the first of the form of the first of the form of the first of the form of the first of the

<sup>\*</sup>For lettile if this setbod of centing tonormin me Winerry, "morthwoman Sture Coll., 50, 5, 10:5

of the adjoining restorms of waves of igns that is, the until light-waves, and latter there were have just original to origin a said on be shall question it is esset to the the there is a shop the small as comparts) with as welcon gift of the Zo I in the are right is out a rest, is 14 on both are the are, and 1 put same or cas except that the builds are successive colored spectra.

are a tamori from diffrant on entirects of the contract of the state of a er cree and any price of Phase and the state of To see a few of the second A CONTRACTOR OF SE . NO Lister to the Thick all ter dote a group on perfect a tor &

338. Double Refraction. As maked in Am 326, all cristallized a hof mees may be thereof not we proceed a conserving a dropper in at the specific streame event to be the post of the threethe alas is strated in which has been a few to growing ones with the the rest of the tent with the state of the see of the test of the state me was the age of are and to be got a seed a state the set of the term of the second of the term of the term of the second in detail further on.

In the lacted in a like 322, pplying that a remoder to reason in that in the many defended in the second to the television of the second of th In the de the way we start to organize it has no secretar water there are a gent and a case, compressed with There are believed to the transfer to be built to be built THE THE SECTION OF SECTION STREET, SECTION SEC by the last, all the plant of the page of the terms of the same that the Had be a specific and short age a to be far at least with arraw revised the contract of the personal Burn in letter on l'and the and he are the

The care't top or their the second ty the temperal refrance in the same of the sa of creates to Timb & do a fill to pay the stronger through and a server a to Fig. this Donath of the sign test of a second of the CIA, I. A. SK Filter tet a - x to system for participating to the property of th the deal of the south steam the area. then of many personal machines and and the phone area so a take a contactor file



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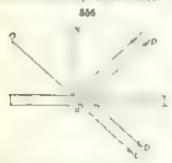
339 In the refraction and a Ken paper to the an way per mailing just mentions, to the negative tiens wit what he mention is a company dicular to the surface. If the mean it bearings to the unitarial cases see [ 277, of map), one of the rays idways retains its initial direction normal to the surface—but the other except in cortain special cases, is in the or was deviated from it. With a blood substance, further both rays are usually retained said bent from their original acceptant. In the case of both unitaxia, and bravial models, however it as a lightly that the normal to the waye-front remains infinitely with persender surface tence.

340 Interference of Waves in General. — The subject of the interference of against the state of the 337, requires caralled discussion. It is not of green importance since, serves to explain many common stall beauti

fur per transmit in the optical strity of crestals.

Referring again, to the water-waver spinor of in Art 313, it is easily incensioned that when two wave-avoiding geing and for exiting a from two cor one of dail where next one at other, come together if at a given pent that meet it it example he of each together. On the there have, after my positible two wavesystems can a logother of opposite phases that a third a wave-length apart, the cress of one is reasponding to the triage of the other, they interfere and the might use of modern together their equal case. Therefore and the might use of modern waves of outlook applicate, our theorem, two sols of waves tony up one form waves of outlook other, they make the triage of the case of other makes an interfere the late of other makes in cases a between these xtransactions in general A years matter one to trip also of sometimes and the makes in A years matter one to the angle of some day was species of the case of nection my was species of the case of nection with the source of a swaves carried by a only one Arc 315).

341. Interference of light-waves. In erformer places in a seat be most at aster. The stronged in the case of again waves. The extreme cases are fact to was lift we waves if her beight and interesty, and propagated in the same direction most in the same place any material waves differ to the same place any material waves differ in the same place. This, as stated to Art. 316, will cause out a crease in the materials of the light. If a waver the waves differ in place by half a wave-sength, or in out in thipseless factor of ferrest lexingular, each other and to light resches for their relations of phase and its discussion of the component waves. In the door cases, consolirous in light waves each of the component waves.



were use thee city as, those or de length of orderer white light is most interconnected early at wave-lengt a new result with the consecutive saluracion of the corresponding color from the white light and so give the over his specific volume.

343 Hastrations of Interference - A simple it was no per florder by the anglit crities of the anglit critical enhancer, a sont both and the cause To understand these it is only necessary to remember that the increased aght waves are reflected in part from the upper and in part

from the lower surface of the figure plate. The mass that are reflected from the under surface of the year than filt uses Fig. 550 having traveled a greater distance and with a different velocity will, when they are a with those rays reflected from the upper surface, show in general a different phase. For

some particular wave-length of light this difference to likely to be exactly and wive ength if whe add may be fithe amount and so the corresponding of the comparison of the c

A photoconvex lens of long curvature restrict in a plane glass suffice big 557 on I hoper separated from a carego a the center Ly a han of our

If varying the expressing the by reflected distribution make light a new order and most light a series of light and distribute to go called Ventinia range. The link are triplet of the light profession of the

557

it client and collected was easily after a first explicitly behind the form of the high rings expressed to the discrete where the worst is if reflected was required in the age phase that is to right was all for soldings of the begger; he was he for soldings of any one has perfect and those has age the begger; he was he for soldings or any one has perfect these and correspond to the perits where the two was easy not in appoint these and correspond to the ring a waspless to reason to a perit of the archer are fined to be any and he rings are found to be an in the perits the cause as a straight of the light. In each of the cause as a remaind the ring is properly the intersect of on the plane are force of the cause as a straight as the reason to be and the

It and may white aget we go protected the a compare, got and box range assembled there, a series of our pat har is If the a state of more arrest in the I visual arm, ght the point of the 1 th tings pile this wire light for that lest sentar waves, or gib the best or regulated by age therefore to Wire white light properly he conditions in respect to its component having the you are soon properly reasonable before me changed and the right will at the e countried at the same people of them between the true rough we get it we have dig the complementary collection. If our open I have a markety const In the right he dirth rings was all have built of the root that it is her procitions a said our light. And again when while right is used not upto a himstated a those points and its compresentary or or shows. In this way we closing a series of colored comprehensiving the environment or more of the spectrum. The series of the spectrum oil is are reported to the series in the The to successive ofterformers progress to offenences of price of 1 1 11. etr wave-r gitte the afterent series are distinguished as of the first, record third etc., order, for a given contrast red, may be repeated a nar der of times. The interference rings for inflatent eclored lights are not even y spaced, the sings shown in this ugot being for nataneousleser together than for red. Consequency after three or fear espect one of the spectrum bands the different interference rings begin to everall one and her heal the resilting colors become fainter and less pure. Unmately this overlapping becomes

a percent in the subject of are not as I where extra the second od where of the higher orders, is shown.

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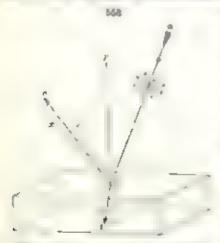
or of come I from the the the way of a second of the first of the color ately a to the respective and the top to

343. Polarization and Polar sed Light Only in till a top g and by state first transferred to provide the concern a tell and the entry of the feet of of a ten-It is a sear of the angle of the second of t e is to Art but as a six of the territor and to the temperature

I' we can all the or a good of broth, a Art 316, in prejugace to the ter a compression of the the a critical and the state of the state of the be a file to be to the state of talks De vi t 1904 section to a distribution

har a out a two co heat I by reflects a and by surgic refrac-

344. Polarization by Reflection and Single Refraction. In gen-ru-



agt which has determed to a rise of alkela will old assets to to the work part I professed that the think the state of the stat the same and the extent of a good is agreefly fat, and a security the That we have produced property. to be seen a larger out of the state of and the street of the street of the p range at a refer of vitter PERSONAL PROPERTY OF THE PARTY OF THE PARTY. to promy a man the the the the the state of the s erze para , the rose , mane at the present to be emper to 1 house r and a second to prome to prove before I a to brough we in the state awareh the Victor one are against the all plotso r transce had as he reprewe so by the provider of y and . I

War to my armine he pelanter and an enter and and amplican part of the I grant a second of the second the mile was selected for the contraction of the meaning the state of the supply Deal trival To grant to a grant of the total Why create too response with an a part of the color, buy a family beginning the some will to state and in the topographic in the collect and an extent preferringed and a proceed by are a medical to legis property

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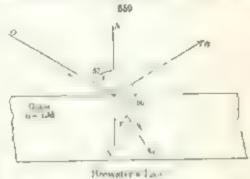
from a polished and transparent surface is not completely promised but there is an angle of me dense for every solutions at which he imposed if politication will be the maximum. The will trappe a solutionable in Fig. 369, when the high between the relaction and retracted crys 4 B and 5 C equals

90°. It is evident from a consideration of the figure that the angle r is the complement of the bears the formula sibr = a laconness in this case

$$\lim_{t \to 0} = \tan i = a.$$

This law, established by Brewster, may be stated as follows:

The angle of incidence for more many polarization or that angle whose to good to the in a r



of afractive of the cells and arctimes. For crowingly so this airple in the at \$70 and high alfall in the removal of the properties of the

346. Polarization by Double Refraction. When light it pesseng through a creater the from it is cloubly in ractor. At 338 of a field in a state of every it is not as an that he is precoperately personal that he prince at one be extracted that it is not as a right angles to the later as he of he proper is the at soft proper in the attack of the proper is the attack of the rest have been the it must be all and there is a this proper is the attack of must be refracted to the manufacture of the case of the contracted of this is account a set in the manufacture of the case of the case of the manufacture and the manufacture of the case of the manufacture and the manufacture of the case of the manufacture and the manufacture of the m

348 Pointreed Light by Absorption. Light passing his agh a strongly col red by reservat II in section of a tours of a rysid the section being out part of to the veri al revisto or it to the administration completely polarized. These make a victoria to the following way Salvet and applied their surface or a total top and a to the chie position into light from a win loss a rollie sel from the god shall seem a the eye Lank of the real transfer and no top of heart all region I talk the less represent the directs of the elegation as in a horizon a position of the tarring the marian and the example certical Though printing at the torprovide an extraction of the policies, and are reduction from the wood surface one processes the rise in subration dies son I will be noted that when the axis of the corrange is a part of the section readly transpars I got but wast thes are a vertical the action lies are progressly Opany to The cays of structure of the temporal enter a such that light entermal it a br ken paper a tays a page d, not cited one of which has its vitrate as parallel to the caxis, while the vitrations of the other he in the plane of the horizontal crystal axes. From the foregoing experiment it is

obvious that the light vibrating parallel to the classes readily transmitted by the crystal but that he stour read a brating in the Lanzesta, and plane, a subject or a process of the stour disserted. It for these conditions it is constituted to the stransmitted by the tibrations of which take place in a stage force in the class words, the agent transmitted by such a team arms seek in a positive?

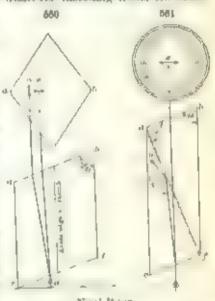
It is each sections of a grantine are available it is instructive to make the following experiment with here. Place their together, first with their class parallel to each other and their own of election upon the their and these are are a right engine to each other. In the first case, the light comes through the section term of the transmitted rave in the account of sections are parallel to each other are second case all light is cut off section as now these two extremely places are at right angles to each other through, that did get through the first section being wholly absorbed in the second.

347 Polarized Light by Double Refriction. Calcute as already at ited the Art. 338, preserver in it is as all degree the power to doct a retract light If we take a cleanage ology of the great to Leelah, apart and or har a on ge through it, such is a do, or any frawh of a piece of paper, or in age will appear on the off we take a earl and trace up at a purbacing the care apon one free of a eveny use it sengents and looking through the cale it, held if up age are a secret of a time we observe two leight hote. Now if we lak bile saa way at a ager relected from a pendaga wasder surface no describes the proof greate, we will find that when a to spect of treater arges a first the fire of the elevage theck is horizont, and if tion I get a bright while the other or a most broken if we then then e dux at the life weeting be a time grow of the thouston for a this company between the form to the ego in the letter of the bering that the ight rejected from the prinded unonest surface to large a the arguid with a foregular, there in directly of these has exceen from a deexperient that he two rays of and he light a probet up it present the glother or care perested and that their justice of a roll are of pertinger to each other and respectively tracel the apples to chamble for of the charge of the k. As the modele refraction of concite is strong, it I be say it at the statement property in if he take pass show come here we influe repeated this fact is take to a stage of it constructing a present from colonic the school was restricted as a trace of the cross section is one the other may out come torough for prism, offer ive a printing he will get one organic

The prism receives to the variety bed the beautiful as the a soft power life and the as the power life and properties of the construction and seem in the following properties of a seem of the life and of energy with the engage very call that a represent of a seem of a selection of energy with the engage very call that a represent a power to be broken not two mass at use packs through the chombone or have shown to the life and a shown hove, there is a case for a receiver with the construction of a factor and the large with the large and the large with the large and the large a

two surfaces, after being polished, are comented together by means of a thin layer of Canada relson. Let a assume that a ray of light exters the promotion below, as shown in log 561. It is broken up to the rays o and other ray o travels with the slower relative has therefore the ligher index of ration, and shows a greater devia on from the original path. The anada bulsam has a lower adex of refraction than ray o where therefore, when it strikes the layer of indeans, is a compling to pees from an operally dense into a rater medical. The construction of the gream a such that this ray in cets the layer of bussam of an ingle greater than the critical angle for his optical combination and adders—erefore the relation oward the rate of the gream and will be obserbed, by whatever his easing hours the most

The second ray a passes through the , resis with almost no deviation from to empirical or area. Its index of refreston and hat of the canada bas in are meanly the same bence he may calfere amost no leave to storie pent and popular not of the upar for for the trees also gt in replier on argen from a most belongs to may be one can take and brising paracel to to shorter degreets of he ractal c e l'appare Ital. I, ho notec busy eres that make primary are as do to a I lepent way and the the above statemer by programs the talker faithfull in of the light our riging from the prists to sy n ) idways I id true. It is al-WITH WHE IS LESS the plant of these tion of a mood by newing through it at the four or a task op na previously hearded. The prior will show height when to please fail or man her way ta, the corresponding to the plane of vil pation of the relocated right

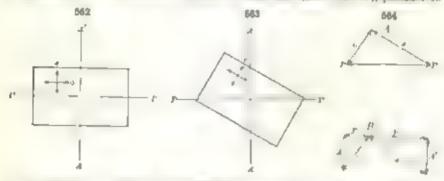


Ninck Prism

348. Polariscope. Polarizer Analyzer. The confinents of two many of the polarizing cut to a confident which is natural time all so may be exalted a polarizer light availed, it general is post on perfect the common forms of which are coscribed later. In any polarizor with the cutter of order of transfer, whose polarizes he light given it in the cutte is so are is easied be postanced the upper prism is the order of the transfer of the upper prism is the order of the transfer of the transfer

349. Interference of Piane-pointized Waves. Interference Colors. When seets us of dod v perfecting manerals are consisted in pull-reset high review atterference effects are commonly abunded that are of great super-tunes. As shown in Art 347, calcing when it follows refrects us also parameters the two rays and in planes that are at right angles to e set other. In general, thus is true of sections of four by refracting materials. To lead of, then, what takes place when a general section of a dealay refracting innoval is

picted in a polariscope between the polarizer and analyzer the planes of vibrail of which are it has single to each other. In high 5th at the recting has on the recessor are seen. The only the arrows marked counts
at a first two passers drown as of vision on light to the seen of the
arrows in P. I. represes to he post of vision on the distribution of gets a set consequently to
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Is briefly Part P at Fig. 460 B will be discribed by the no year lapt be rays to seed 4 and 4 intercepts and med 1 into the seed to seed to be a present to seed to be a whole distributed to receive the seed to which to the first total for the seed to the first total for the first total for the seed to the first total for the first total for the first total for a first total for a first total for the seed to the first total for the seed to the seed total for the seed total for the seed total for the seed total for the seed total form total for the seed total

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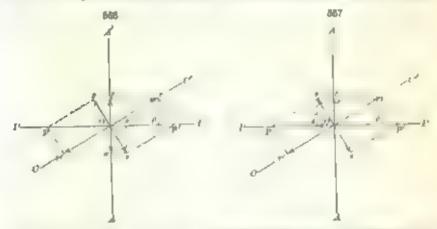
the chrection is that of the ray which is propagated with greater relocity. Some an gesture all with their eager chrection people to the vertical axis a quarter and the array in this case will be marked Z or to, which increase that he is the short on all the share rate. It is also are case that the share that the share that the share is a present of the wedge by known

The years wage turn when prompte section a varying thickness and I known in about an and to as an essent at its the effects I polar yest aget I at a step september of the wedge I lift pent thankingses. Take the st a firm distribution on the time the street on sign without he was up or duty with a bear of the many ment of the property ment of the property of the pro or take the continues go at the stage of the mary nept to acc. elected weeker with res I direct to parallel to the claim of a ration of his polypage In the interior of the court a will a trate mobile to the previous and warfour of page of the property of a section we make through he marks and up to the of the above above it will sufter total reflection. It is a the weather to be properly will allow at his horizontally dis for get. A statement not the last to the whole the Andrew of the wonder of most part of to the searce with the or to the many Real of the tendent of the total I leader to be at thate, and I we he are it intract of the in a fer he was well excent a serie of here to derfore or a few are T year of the a route a long time to the first to a like constructed to a stope , regrets if he was a series of the production called belowing cas and from the said to the part of the said to topy and

As place to be an ear offered a part a matrix stan of later. I P by mile the op but our deal squits wronge Illy a bill e the stige of a pad course without a course of the thors with lift coul a tent is and analy a new ord of these a particular without with the I he of some extent out to a director or our let to All to the the the tent of the total to the tent of th or a design in a part of the state of the st if the took of the credit tour is here and is a cop poor after any four than to bell told of the lives of a cost to be detailed a love made to the comment of the state of the on as step of per the passes of each hard as it morned at a 505 B and amber them a reagat to tracks he as parent of the wedge. The a total , begin , the he prove where the west of the face tax is in which I tought to war it do a wall take was a destructioned to be made bright in that I operated the slower tex. At he pent doctored 2 the goals is two wavelet w hat etc.

In exceeding the phononecount, is been the distance is made to Fig. 1860 in which it is not meet that if it is not a section of a positive and it is the provided by the control of a positive and the control of the co

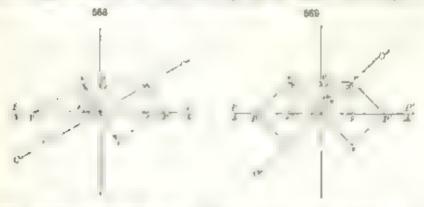
sented by O 7 and O x are determined by the parallelegrum of forces, as indicated by the dotted lines in the igure. During the passage of these two rays through the quartz the case whose whitst has are represented by x x' travels the faster and it is assumed that the thickness of the quartz wedge at the place under consideration is such that calendrously this ray is just one wave leight ahead of the one whose vature, do any partial, to rer'. Now, while one cat is exactly one wave-length ahead of any list is may be two, three or any exact a maker of wave-length ahead of any list is may be two, three or any exact a limber of wave-length ahead of any list is may be two, three or any exact a limber of wave-length ahead of any list is past starting from O to a cat other particle of the ray x x is past starting from O to a an other particle of the ray x x is past starting from O to a safer the off sets produced by the samily and starting from O to x and O to x upon the other particles of the chart considering the analyser.



It is wen to compler next the effects that result when with the planes of vibration of the nicols crossed light travels it rough such thicknesses of this quartz wedge that one ray games [1], or some other had wave-length over the second ray. Let it be supposed, Fig. 567, that at O, the modifie of an essellation from p to p', the in pact is communicated to the other particles. I a quartz section the vertical crystal axis of which has parallel to the interiors C. C. There will result two disturbances in the quartz, one from O to r and

the other from O to a. After traversing the sect, of the places of the two rays of fer by one-had a sus-length so that when the true not of the first use had that is from O to a the train of the train of the place of the section of the train of the majority of the place of the first train of the majority of the first train o

And the process of the state of a compact of the pulsars



some produce by a restord of ensent as to the previous ensent II er ter erses som a tot be seen to otto the an analytic state of the graphed to the high agent right over a country comment of the time In the state of the about the second to the end of the fire of the contract It is the twenty and can how president and the medical result. by this trent to do to test by ... It at these trees, an other with the deal to the of while the and force of the house he will be types a the total or of the theretory are property and arrest top of least A merger of the experimental to the end of the property to the thirty appear in an electronic or the contract of the annual terms and the second of the contract of th easy harver of many topologith the in an analytic of algor of to with he dere we retrained the committee to the an other perior of the comment of and the act to be any extra study of position drover up at no re no e other are, theret pe a lime pro- not stay seespecial for a second of the following of the state of the second of link har ta the same of the part and a tree and the land where one to lasgated converges the secon, some of a great flowing long is, etc., sector secretors to bug to H postone i he bards in the experiment in a , a fel la the creases to aked of the step of paper the second upon one ale of the quart weary. The area and reserve at the to per strip to enting gail. If whole and entertail was e-long he for yellow he this has some as a stiff me points for farther considered has

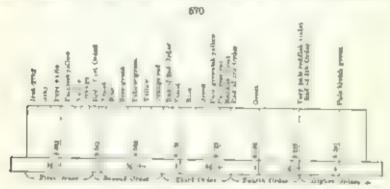
For the next experiment use a macroscope with crossed mean, a number 3 of

4 object, we and illuminate with updensive light, place the wedge in the 45° posite it and focus on coat part of it opposite the first had drawn on the paper strice. The field will show at a section a specific about at the just where y is begarning to menge attend A me and seems door a will in Lente at a this end r rooms at I is a to y are of the entire exerpt they The this sine case in a full road by roading will not by the ma d a special decision appearance per this will show appearant they ghave all oh rurs a dark tond advect to the an arrow, that is, when the vertex swon of from all the time the wedge or the proof to the perfore the complete in I selly which to accord a deciptor of aterior ter-Next home the increasing parties of appearance of section 1. There has adar spalm hears a say one with mer also arge of group. I was and we e thilles writemore as a debar lar when I properly the more the or the margine brought been by weath rever, phase we are legtles for such that a glob throwseeing much be only a die only a die be ferral to was light green what on an another want and set rear box still win all a larger to all principle, a green that a men of the outtopged her a contain not good tops are beginning trace on any 1 by a very limit at the well than it are as well an appoint man party of the IN I STATE IS THE PERSON OF TH planting for haten at an he given and small fintherenal 1380 and for seeings has been burnerable or property of pagest as ald as a hear for that all here of the arms when the forthe by it rivelles hight was love of that and blass bear fitth hatel for the I right to say re y the net years a register pour fithe wage of buttoned to she it but from which but with all a morning be the end the weaper fext reach warrier like best by two addition by to I der regt part becaut endler entenliger eines en gen und the wedge is carbed a the governor a super size of the larger to or many with a long agree on prospectation with the army great and ter I men were at reprint the order and the rest of the poster the fast or care has greated a program on a very character accepting of vellous ght, for green the fer at the law or polarize or office, or exact and tag titlespeed will the over a specient we will be filled lightered to the matter of the sected privary colors for specifical, wine the factories of other still like in the first of the collections white

I surport in this tray everyly the pelicipation of the prints were mart e a marine work by " waste to It will be near that the man entringer out on te con a derivative three entries of a HOTELSES ARE I BY EPOPER CLOSE OF PLANT IN THE SECOND OF THE SECOND SECO make ted que un a de a desertique de la como entre con la ser ge and progression of the parties of the parties of the parties of Harmery col page ded proceders and the neigh it has abs ho od divid the very time ad of the across out in any a cer report of the taken passe the color is where. Also so however, fith come a view because here berries an work plung for a north poster. In enforcement of the different enters. The thickness of the wedge at the different posts in

given in millimeters in Fig. 570.

360. Sensitive Tint. Among the correspondent of the policies of a leave scope is a than paste of gypsair, a mante, be and a two patre of grase. It is continously marked S.T. and also with an arrow marked either X. at or Z. (c) and a tag respectively the directors of a bration of he faster it slower may if this is proved in the microscope in the 45° position with the mentionesses), the in effective case staws is restably violet. Or some as that a restar rest of the tags order of the pair a wedge. It is an in eresting experiment to first put a quartat wedge under the in eroscope and these on the restar at the total of the ties order and then cover it with the sensetive and arranges in such a way that its A threat on is a right angles to the



Interference Course with Quarte Wedge

X direction of the quite widge. The resulting color will be grey. The exploration of this scan ple. Whatever go in the faster my had made over the slower in passing through the quite a has been evereined in rules by passing through a wave of gypsen of opposite ordeal encreation and of sunticle there are to produce the same interference as the quite. Doe to a Sensitive Test is given to this gypsen place because a slight increase of the could refer that which is a war will give a black or in a corresponding sing the times will change the relative bullow. Numerous uses of the sensitive to the foregreen is also represented as the first whose given it is also reported as the first whose given it is also reported.

361 Interference Colors of Miners. Sections. The interference colors

of numero, seet, ages epend from these burgs

I shall strong a of the big ringuage of the mineral or in other words upon the une. of deable refraction the the mineral shows. The greener the livety agent the baguer the order or interference color, we office and serving factors remaining constant.

2. Incollect we of the section. The three the section the greater will be the another of to jide retraction at Lectusquerity the higher the order of

the interference color

d The crystal ographic orantation of the seed on. This will be explained inter-when the quite largeters of the different crystal systems are described.

362 Determination of the Order of the Interference Color of a Mineral Section. It is often in portant to de armine to which order see ast paragraph of Art 349 the interference color of a grown section amongs. If 30 a often is easy the section has set owners a tapering wedge-bke edge the successive bands. I color shown here can be counted and the order of the color of the surface of the section determined. In other words the order of the color can be told in the same way as upon the quartz wedge itself. If such an edge cumm by found to quartz wonge is used as described below.

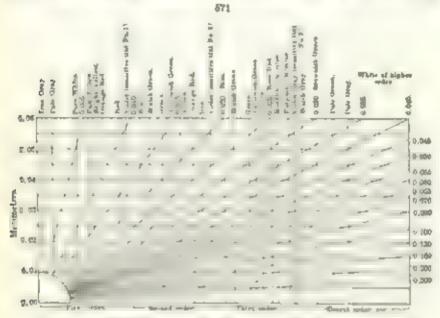
Suppose there is an interest on the control of the preference of the first of second order. There is an another with the control of the second order. I have the memory be well of the second of the s

which the tree constants is proved to a purpose

I therefore each one then he two posts as I then the optical ore and the south and the group gree or the A dies in it we do a part to the figure to at the wedge or these two corrects as barght agratementer treffer to reduce of the wing were the ser was who want of their ow referred to a make of concilprinting the gibt . A manor at If the double print the is developed he were offer well a sit a morning of templations agrees d and to be come a present the arrange of the port by the band. if it is the refer out to get to recovered by the derivation, of the enough we don't ender white positive ner we are tand there to and and to appropriate and rived by the distribution of the light own the red on or eter many the are on seal because of get a merge to make at their a see a full agreen lathe as all on a woole argule menge, en they a of grown Arrange to merch, is not in as at spate to I am the result the entry periody the interest energy of a fall of the or my Then grad als cop it is to paid, a the works monthly the suppressive colors but or it as the amount to a firm recent on a ferminary from by the or of will be readed about to the knowled the wedge was practically the same all aged of the me person, an is to an art are in The two test and op the are proceed as as the rest will be recorrecte alcusterform a and a gran or or of the tree order a long by When a scondition great de places. Window is an I to compen the the survival to to my he succession I call on to t occups antil to specify is mached the prior of the original wor of the were en our ho the certificat

363. Determination of Strength of Burlingence — The barefrongence of the third of dishect effect on, years with different integrals. It is expressed his to make by a liquid to be the off peace of weak, the greatest and a set a reas of refresh. It is given and the limit of the other is 1 and a set the larefringence of a lare through the set of peace of charter being a fit in the make the strength of the larefringence of a larefringence of the larefringence. If the first two factors are known the larefringence can be estimated by noting the interference color of

the section. Fig. 571 will and in this determination. The thickness of the section is shown in the co-usin at the left. The strength of the bindringence is expressed using the top in 1 right hand site of the figure. Suppose that a great sect in was 0.03 and in the chaese in I showed an orthogored in exference color of the first order. By following the 1 agona, he that crosses the horizontal line marked field mm at a joint ying in the mid is of the orange-red of the first order t will be seen that he timely inquired in the numeral noise be about 0.015. This method of hermining his triaggrees is most commonly used in the case of numerals observed in rock sections. In the case of the best



Determination of the Strength of Bushingtone after Person and Robinson

The thickness of the steam is one may be proper from the interference color as we be proceed in the steam in the steam in the first of the buckting occupied at the formation in the steam in the steam of the buckting occupied at their varies with the steam of the steam of the buckting occupied at their varies with the creation of the interference of a terference of the maximum interference of the maximum interference of the interference of the

The order of the interference color of a given section is to be determined by the method of conpensation as explained in Art 352. Special quarts wedges are made with scales upon them go ng the birefringence produced by the varying thacknesses of the wedge. Such a wedge, described by Wright,

consists of a wedge of quartz placed on top of a plate of quartz, the two having of posite optical prientations we, the Z livetion in the plate being parallel time A direction in the wedge. The thickness of the plate is incern educate testween the chicknesses of the two ends of the wedge. At the point, therefore where the thickness of the wedge exputes that of the plate, the will be a dark but showing compensation when we can build it is placed between chessed mode. This point is marked zero of the scale engaged on the wedge. When the wedge is placed above a finite of section, thus tark line will be displaced by a distance proportional to the box frigures of the materal. The later can then be read directly from the scale observes, on the wedge. For a detailed description of the virtues wedges and compensators used for this

purpose the reader must be ref rest? In re-special text - stoke "

354. Determination of the Relative Optical Character of the Extinction Directions of any Section of a Doubly Refracting Mineral - It frequer ly becomes insportant to determine which of the two rays of light in a doubly refracting minera, is being propagated with the greater or less velocity; potent words, to determine which of the on directions of valuation correare add to the A and which to the Z direct in Phose the given section under the querescope with the nine a pressed. Fig. to per total (Ampeliou and then orn the ser out through at arc of 45° so that its vibra on directions make were angle with the planes of vitire on of the facets. If the section in that posed in shows a strong color or write of the higher order the quarts widge is assel. The option of an atom of the wedge artist be known, i.e., which are its A and Z shreetions I to wedge is then , inheal through the alst approache object we less, the thin end of the wedge seng datableced first. The vioreto a direct one of the wedge and the section will now contends and the effect of the grad all introduct on of the wedge sheve the amend will be to slowly moreone or feerenge the tarefringence out to the section. The result, will be together man or I were the mar of the a erfercage rotor obtained. If this A directions of the widge and the section countries the effect will be additive in character and the color will recommisse refer of the openal characters of the two are epiposed to useh other the threfat gence is engressed and the color was full. By noting which effect takes place the A and Z directions of the section are determined

In this use of the quarta wedge the following precaution must be observed. If the sign on origin, by showed a color of the first or let on the wedge was introduced a the opposed area or the effect would be to cause the court to full impairs to gray of the first order. The operad effect of the quarta wedge would thus quickly compensate that of an exchange from the point on as the quarta wedge and order that of the section from the wedge will trace and more proportionate over that of the section and be interference colors will now appear in ascending order. Under these conditions, if he first effect of the uppear is ascending order. Under these conditions, if he first effect of the uppear wedge was overlooked, a wrong asturation would be made. It is always test to repeat the test with the section is usted 90° from the first position. The two results should be if opposite character and so serve to con-

firm enca mare

Frequently a thick section of a mineral will show a tapering edge somewhere which wal above bands of color. When the quartz wedge is nitroduced

<sup>\*</sup> See Johanneen, Maurad of Petrographic Methods, Wright, The Methods of Petrographic-Microscopic Research.

above the section these color bands will move either toward the center of the section, or go off the refer the edge. When the court bands have up on the section it means that he edge when the quartit wedge as a body in the corporation the section is now about the quartit wedge as a body in the corporation of the section is now about a significant to see the health that the most funder. If this is so, then the N and Z direct he of the section and the wedge must be opposed to each their funder that the cart into the result of the section it means that a theory part of the section and the arrange of the quartit wedge has a threat part of the section and the norm of the section and the section of the court of the section of the court of the section of the court of th

It a materal set in a convenient interference color of a ato or gray of the first order the sensitive that was give to be ment is the the sensity wedge. If he siteliar optical directions is the section of the section of the color all the color will be to receive the sensition of the processing of the section of the processing of the section of the processing option of the section of the sectio

compared the second or a respect only to the or or or

355 Circuariy and Eliptically Polarized Light. In the presenting atticles the two in ordering glot by were energies from he seemed the were assumed to be polarized in the same print for the other resulting the nomena as in least their comparators, a upon. It however the print polarized rays propagation in the same one of large hear a returned a wave-length class in place case andig means from a region of the resulting the character of the same of the comparation of the same of the propagated at the same of the same o

If, again two light-rays meet as those assembed with a difference of phase differing from 12 but not the sure of the control of a fact on manager continues to a gives the time of the control of the con

gated by electron a tak of block to the poer-

The above rest - in the most a state point pressing plane-polarized light through a districtive retrecting mestods of the report pressure of a minute plane which is traced with a velocities plane in reset 15 to that of the polarizer. In the thickness, such as to give a difference in plane of the odd mentiple of the time glowner emerge is it, both proceed. If the plane difference is from the plane difference in the case of the case of

356. Rotation of Plane of Polarization. In the case of certain double refrecting crystalisms, there is quarts, and uses of certain miles are of sugar. If can be shown that the agest is propagated by two sets of other vibrations which take there is in the first transverse planes has in plane polarizate agest — but in circles that is each ray a circularly polarized, one being right-handed, the other reft-handed. Further of these rays, one will

or formly gain with reference to the other. The result is that if a ray of principal arrived light for upon such a merican assuming the simplest case as of section of quartz cut normal to the vertical crystalaxis, it is found that the two rays care marky polarized within instead of a regard to a plane-polarized ray but the prior of bod rization loss affects in angle or change or rotation has a fine a ray of the direction of the ray, when the substitute is said to be right-handed, in to the left, when it is called after right in right.

Last promotion is theorem ally possible with all crystals of a given system belonging to any of the class of most synthetic than the normal class what is now a significant incompanion of the faces, or in resumply, loss at which the corresponding right and left or a said typical forms are countermorph as upp 23 %, 129 has noted in the chapter on crystal-agraphy. In this endogy this suppose is most upon any with the common species of quartity of the resolution distributor is a class, and a farther

discussion of it is post per all the rate page. Art. 402

367. Abnormal Interference Colors, there are factors may at three models the ateriors to observe we by a near all section so as to produce a proper of the material section is a treat in the astrong the interference color to be considerable continued for in unnearly may show interference color to be considerable continued for in unnearly may show interference color to be considerable continued to the interference color than have practically active to a color of the colors of

# OPTICAL INSUREMENTS AND METHODS

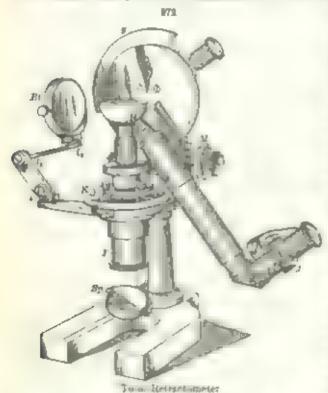
358. Measurement of Refractive Indices. Refractometer - For the discrepantate poli a refractive i Legal ervoi Il sed in nerde varione methode brempowed. The most scent at results, whereas, at a material is not appell. they be to much my as pointery retractorater. I as for a rest the observation of the style of man in the even on 8 of a hight-ray on passing through a by street the gave a continuous gar known and a my with the or grant in the proper direction the acceptance to figure at the mane with an the many refractions at a way the horast, gon one fer beserved in Art 236. It he as or protryment the charter of the stat dury being fraction of the neglect the temporal region of the tearning to exceepe with the verm as my restricts. I core for the set the grade or encode or commonly an a cycles. Backup is connected at 6 the xis curring the support and the vertice early and a serving to scope are make non-lagat from a monochromatic source passes throng an operation dit soil at mage of this is thrown by ne cold in dor upon the prism. Write a limby retricting substance two integers are the distinct that might of improvement value a measured

Of the that two poors is chosen among errors the fall using success one harder at the set of the poors of the fall of the poors of the fall of the poors of the fall of the poors of the

for each the proper direction for the edge of the prism in this case is discussed

later. When a min 5 are known the form us in Art. 333 a used.

369 Total Refractioneter. The presuper of total reflection (Art. 328) may also be made use.) In between the retreative index. A prising required but may a small fragment but up a small fragment but up a small fragment but up a representation with up as more crystal, but in of er cases much have a debute priential, it is become trader. A number of different instruments have been devised by means of war in indices of retraction may be measured.



by the use of total reflection. Wit ery daed at present a represented in For 572. I his nurhowar matrument was made by Lease. It consists of a hone sphere of glass II. having a high referetive of tex which is mout ted upon a glass. pret through which he of their be reflected from the merce No. The take Perstains a t- out their an that WESTER IN THE APPROPRIES benelig at branta a fo upon the mane surface of the herms at the at he possible t of that ity optical chichiation to the some matther as with the tuning ng mi reacres. The polymed n neral sur ace is placed mon the mane strainer of H water a film of some last, re-

fracting off between them. Then a beam of light from some source of illaumintion, usually a min whenever of ill is reflected a means of the unit
for Bi in such a way as a produce a cult is reflected a means of the unit
opposite aids of the hemisphere. In order results of the open on sec.

Art 333. The telescope I is attached to the use I which is tart carries
a scale on its edge. The ter scope is in the ap or down until the airc is
tween the light and dark particles in the held be on the cross-units. The
angle which a read on the same of the term of the hemisphere
is a scale on the communities of the glass of the hemisphere
it is possible to calculate the major of retraction of the numeral sec Art 333.

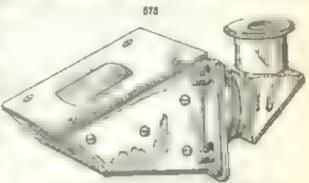
I study a table is turnished with the total tetractometer by means of which the

desired refractive index is obtained directly from the value of the measured entical angle. The post carrying the glass heimsphere may be revolved in be by resortal plater and the single of roll blook measured on the scale K. This permits the pressurement of redices corresponding a different a leption treejudg in the mineral. L is an eye leas which it cor I manage with the other senses of the tube F trakes a less power interascope, which is used in the pre-I havey per thous at order to center the maters place, etc. In the moe A

as no one dural rights and negative a sit all recol priem that may be pushed in or out

of the tube

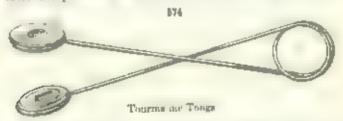
Fig. 573 repreremetons endes and by G 1 H Smith who had reported affeon IK men e frirespe The mount plate is perced open by glass surface one which the top of the instrument. The Instru-



South Total Refractometer Actual Sire)

ren, is so held that light enters at the forward end and the totally reflected light a set I by means of at the resonanted to the eveniere. A search proced I the material in such a way that the houndary be ween the aght and dark arose is seen supermisposed upon a and so calle insects the value of the refractive unity. For himse six t approximate determinations this instrutrains in very peruli

360 Tournatine Tongs. A very sample form of polarise perfor converging light a shown in Fig. 574. Is convenient in use, but of hunted appleention. Love the polarizer and analyzer are two tourmaline plates medicas



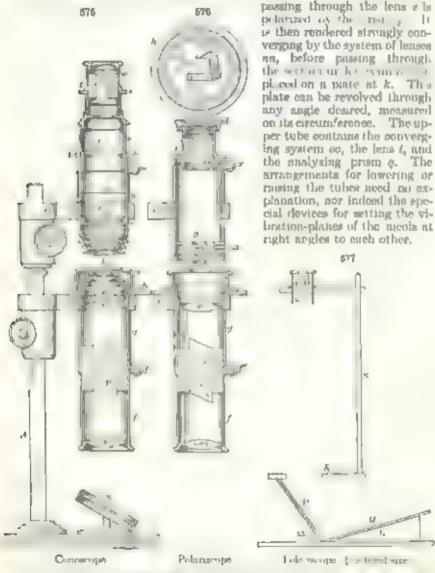
were described in Art 348. They are removed in pieces of cork and held in a and of wire pincers. The object to be examined is placed between them at a supported there by the apring in the wire. In use they are held close to the eye and in this position the crystal section is viewed in converging polarised aght, with the result of showing under proper conditions) the axial later ference-ligtures Arts 397 ap 1 417

361 Palariscope Conoscope. - The common forms of polariscopes employing need prients are shown in Figs 575 and 576 . Fig 575 represents

<sup>&</sup>quot;These figures are taken from the estalogue of From.

the instrument arranged for converging light, which is often called a counsely

The essential parts are the mirror S, reflecting the light which after

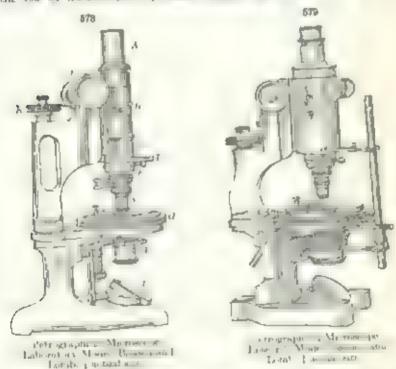


The accompanying tabe (Fig. 576) shows the arrangement for observations in parallel light, the converging leaves having twen removed

Fig. 577 represents in cross section a surpre, in appears that quite efficient form of polariscope. The polariscopy device, P, is in the form of two or three

thin gains shorts the back of the bettom one being backened. These gains parts are set at the appropriate against a see parts maximum of pater subson of the aght replected from them up through he opening in the sage K. At represents an adjustmed quarter be to ask of which aght is not ted upon P. I to an a ter, A present a cold of an abach is held over the exempt of the stage by means at the substantial N. A transfer of the stage of the astronomy in the stage of the astronomy in the stage of the astronomy in the series of terms.

362. Polarization-Microscope The investigat p f h from and option properties of miners all that it are second from the best much form taked by the use of nucroscopes' specially appreciate his perpose. Pirst ar-



ranged with reference as he special stars former is as seen a class seed and of rocks, they have now been so elaborated as largely to take the phase of the older appears to take the phase of the older appears to take the phase of the older appears to take the phase of the result of the area of the epities of an order to were greater fact to the area open of the result of the re

A tig by service of improscope is the Losers as Mondonale by the Burnel and Lorent Operation and districted a Fig. 578. The countries introduced and the contract of the contr

<sup>\*</sup> For lit abot accomply to seef the presenting appropriate and its research see a Marria of Petrographic Methods, Wright The Methods of Petrographic Research see

remarable contains the cross-lairs with at eye long adjustable for focusing mon tach. At B is a Bertrut i less that sie is n and out or the tube with an it's thankrusun, arted their above to At this he ability or box which si es hand out of the body take. This prime may be revived through a distribute this table in the representation with a dest proof sheater time the product mate as accessor, as an and he presented etc. At the the neseptone which all be centered by the two sere was which work at right of come to the A and Lores on the attendance to Figure 1 to prince by a cutting classes and any entropy of relief. The steps, to, revolves and corners a scale gre by, ed at a corgress the attached vertical perm, light resting of applies the coll cogres. The sided age as it trues of tensing class, true disthe gue and the piderizing prosp. It can be do not upward and discovered to peace of series lead and alter at a lower poor car be specific to the me on file presents the interest of some parties of the the I correge arrive The coars for son, who exact man J, while to profess of all A proxy as a his supplement by trachs of which is very carincrement of 0.0005 mm, can be read

363 The Research Mode of the Reneb and Lamb untrosect, a to the trivial and Lig. 5% This is a name to as a cross after one described by Mong a tendebus as service strained at the interpretation of t

to the iris to phenge at next of the sales age.

, should be a decret that the serior of flerest makes of percept pive marries per discontent stems and a little less full course, term however, they do not differ materially from these described a sive.

## GENERAL OPTICAL CHARACTERS OF MINERALS

364. There are certain characteristics beauting to all pureons alike, or etailed and non-crestifized in the result of the fact faces are

1 I satherserv depend good beed and a dy effight crash tied 2 Clause I percong in the kild or light interest or transmitted, as determined by the selection above in

3 Learner depending on the pewer and manner of reflecting agest

### 1. DIAPHANEITY

365. Degrees of Transparency — The amount of light transparted by 3 st., varies in little 8 y, r, r other words, more or less light may be absorbed in the passage amough the given substance (see Art 336, The amount

of alsorption is a minimum in a transparent soud, as ee while it is greatest in one which is opaque, as ron. The full were to run and adopted to express the different tegrees is the power of transmitting light

Transporent: when the outline of an roject seen through the mineral is

perfectly district

Subtransparent of semi-transparent when objects are seen but the certifies are not he not

Improvement when out is transmitted but objects are the seen

Subjected the er marry he capes tratedly but I are treasureput When he right is trained attend even in 'h it in edge . Then uplig term the mineral is see to be prome. It a a properly to a result state enter no mitonance fails to terms a scene tall, it wastes after it at the Magnetons transport pica Per wary mas I ver gold to be bearen cut so hits us to be rubed touth I whall dance I trusted and greated at

The presents of data death at me and a state over the property perfect opace to the programmer and many manufals present, in their mand rous

varieties means ad the different accrees

#### (atax

366 Nature of Color As bracily explained in Art 319, the consallon of cally depends in the case of spea s aromatic light willy upon the langth of he waves of light what there we exe If he place as a of various water-bugt as to as to be combined effect of these that the series on of col r PL GITTE

Further some the light endman a coupe and is report. He when light a sal A rolling bof a little was regress emprosper ting to the a crease or out read the species m, the about it a sets the area to be what we atsorption (see Art. 336) which I exerts up to the granter, or red and by it. A yelion to ner, for any appeared of the way and a specific wall the exception of these search the thing is be second as of sell will be go peral. the color which the est perceives a too result of the nexture of those waves which are not absorbed

367 Streak. The color of the powder of a nemeral as obtained by scratching the surface ( ste or need with a kente of the real tweet of the timperation of the first pe misting it is the first ferre at a legisle. It called he stream. The read to feel a year suspect in past to making ofing mirerals. This is expressed the wal minerals having a fact, a dister,

us cuped to Art 370

368 Dichroism, Pleochroism. - The selective alsorpt in to which the color of a maneral tactor more expects to the equation of all the colors with the crystall graphic treetion is we shall be light a brotest of in men It is hence one of the special spices characters report to eper the crisislimit on, which are the send over Here be ng a a nam or place become, the property of exhat mg inflerent copers r inflorer erve al propine ti rectume by transmitted light. The acties, is explained further in Arts. 401 and 423.

389. Varieties of Color. The following eight colors were enected by Werner as for himents, to facilitate the exp ament of this character in the description of minerals white, may, brace, brac grown, young rest and

brown

a The varieties of Markety Consens recognized are as follows.

a forejular of white of the 3 house grown paretters I Briefer flow the state of the second of the state of the der t is to say a way is the sourced time-grandes speed or a recent fracture auties to DE TOUR A TOUR

Prof. . . . are the varieties of Nun-Marathia Colons.

I Wheel I have a Create within a to so white I bellowsch hite

held a published of the server of read to end out to treemake the server of the server to the state of th there as he has he may be 4 fir worth buck he we could legt c 5 though totale trans-

If he is the section is the process of actions 2 described a contract of eight to the end of a first tenth of the end of n and with red and a contract of the with super rest of the to the water red is a set the end of the red of the water have red of the property of the set of the s

tured of a green section have a surface sedgeth more thy more a property of the transfer of the section of the property of the section of the property of the section of th the second of the second person of the second of the secon

I be we have the set of a percentage of the second at We have a some the second to be a second to be second to be a second to be a second to be a second to be a seco

port with you a second reach to the transfer of the reach to the port with your as second reach to the port of the to that the same that a start a start or the same ark er er fin el a te la mignet de la figura mora red, methodore allange r L - h man bur and he man he

male applies at the Hotel Andreway to the above the Al the complete action of the same of the sam 10 Blackish brown, beturnsous coal, brown coal,

Various at cripts have been unde to dessify colors in see rigally so that one color round be entriprited with any their with a fair degree accuracy the most computerests and best attempt of this hand was made by Ringer way who gives over one thousand different this arranged in a og all order."

<sup>\*</sup> Robert Radgeway 1 cor Standards and Nomenriature, 1613

### 3. LUSTER

370. Nature of Luster. -- The laster of manerals varies with the nature of their surfaces. A variation in the gran ty of light referred principles different degrees of intensity of laster, a vapation in the palare of the reflecting a rivoe traduces different kinds of ) wer

371. Kinds of Luster - " he k to sent tigger recogn and are as follows: METALLAC the laster of the metals as of good, repper, iron, tax

In general, a interest is bill said or this metally laster on each so of an acin the universagion, series that is it pensions to be too the algest of their splaners. Some namerals have vorieties with no albe and others with nonmetaloc loster, the attracef arratic

Imperiect met the luster is expressed by the term sub-metali, as ultratrated by columbite, w dramate. (ther kinds if last riving discrabed brasily

BE NON-METALLIC.

2 Non-Metalate 4 Adamard of the batter of the Lamon- Wien also with intimic it is termed metall administrative is comes to practiyate

A fair it no luster is comes to substrate us of high refraction ranges. I'll s may or connected with their relatively got breaty and ordnesse as with the drame of, ago corumban, etc., or bet use thry contact he ty molecules, thus most compounds of lead got metala, an large have a laga refractive index and an adamentine luster.

R. Vitramas. On clear 4 or near gloss. An emperiority viceous laster to termed auto-dreams. La vitronia ir sub-vitroria lostera are the ir an read of the the manuful kings in Quarty possessive the form it to an orne at

degree; calcite, often the latter

Charging laster of the vellow resum ne opal, and some vellow varieties Of about the

D. Greech, luster of only glass. This is near resmous luster, but is of en-

quite as not no replicate

h. P. ty nike pearl, so tale brumto, while of the When united with

multiprotected is to hyperatheter the term merget pearly in used.

Pearly sater hele to to the glass blaced to us one of this gass-plates. seriously it is exhibited or impersis, watch having a writer cleavage, case be partially separated into successive places, as a the basic subsolationaryllice. It as also down for a sike rease, he foliated concerns, as also and hence to.

F Soling also sur, it is the result of a last testructure and hisrorismal-

cite, fibrous gypaum.

The different degrees and kitch of luster are liter exhibited differently by Hidise fares of the same orys c, but saways ar darry to like faces. For example the sasal plane of apophylar as a pearty dater wanting to the prisquate frees, which have a vireo is dister-

As shown by Handa ger, only yetroom, adamanting an inetal leaters belong to fares period amountains once in the three the estructor about a the norm is to be, it, in some 1, the 2 to in the third, and 2 to 1 is they adopted the ways metally and vitro in mater is cue to one effect which the others courings a supen the refuses aget, to green the laster is produced from a case, such as each mostly a majority or be datasempe of the larger Let 401 it was be to ad that be a rays, that right re a size plane at materies as I that whose transment motivate or a, at make each service the color of the material and liferrong a little of a size of the color of the material and liferrong a little of a size of the color of the first of the light reflected by a transmentation, these rays whose relevants of the right angle of the plane of mentione are more or see polarised, and are colorious, while those where v or tour

are in this plane because perceivated somewhat is to the needs to and a flerry some atmosphilities in with come of the average perceivant. As the string glass the extension is a shown a countries as a real large. Admiranting Lacture see place a position between the others.

\$72. Degrees of Luster. The degrees of intensity of luster are classified as fell-we

1 Specialized reflecting with Eribiancy and giving well-refined images, in

hetnetite, cassiter e

Shoung producing an image by reflection, but not one well-defined, as celestile.

3 Glestening afferding a general reflection from the surface, but no

image, as tate, chare par te-

4 in moreong afforming imperfect reflection and apparently from points over he surface, as I at, ob-centary

A mit eral is said to be did: when there is a total absence of luster, as thalk,

the ochers, und n

373. Play of Colors. Opalescence. Iridescence. The term play of colors is used to describe he appearance of several prisinations on in rapid a necessary of terming the mineral. This property belongs in perfect on to the diament it is which it is due to its high dispersive power. It is also a served in processes of all all end it is explained on the principal of interference, in this case of the peak it is proved by each is sight.

The expression through of colors is used when each particular color appears to provide a larger space than in the play of colors and he accessed produced by turning the lumera, in less rapid. This is all will include an indicatorate is

CXL up at up by that atmosph

Comparement a project or pearly reflection from the interior of a apertinen-

Observed to store and and in cut alove

fredex ever means to extinct in of prime atteneous in the interior or one the surface of a money. The photomaxist of an play of every reasoning etc., are some a new to be explained by the presence of intente former expends, in page to positive a trace generally, however, they are some or or presence of the even age.

place analog as a the well known Nowton a rioge usee Art 342

374. Turnish. A manife surface is turnished when its color differs from that old made by fracture, as is the case with specimens of cornite. A surface possesses the stee to rash with a present all assignments of the color of secupered stee, as color late. The terrish is tried about that late fixed present control, as to company with the limits of allow. These turnish are time to the of numerals are two tog to a thin sect to at the proceeding from different sources, ether from a large to the surface of the context of from foreign tierest at the post is manifest of the post is manifest.

376. Asteriam. The name is given to the pare or standar flux of light observed, a certain invertee is to some in period. This to see that it betted light in the form of a some payed star in supplier and is also well shown by transmitted light too of a standiture with the phogopate made from South Burgess. Canonic in the former case it is expanse, by the presence of him twinning-lamethe symmetrically arranged. In the other case it is due to the presence of minute to each crystalla has examinate case, a transpect which are probably ratile or tourname in most cases. Crystallar faces which have been at thingly eithed also sometimes exhibit asteriam. The neculiar oght-

figures sometimes observed to reflected bolt on the faces of crystals, either

instaral or etched, are of similar nature.

376. Schillerzanon. - The general term schiller is applied to the poculfor luster, sometimes nearly me alle observed in actions arecreas in certain in nerals, as conspicuously in scholar-spar an alterna variety of bronziet, a so in danlage, hyperstance, sunstone and o sers. It is explained by it a reflect on either from in tate included places in para lel positi a or from the surfaces of manufe cast see there it we creat also having a common one itation. In many cases it is the transferred on which last terropear tiper posters or the cavities in the direction of sold a spenies see Art 290). The process by which it has been procked is then eached acuttern, or or

377 Fluorescence. - he crussion of agent from within a substance while it is being exposed to prest railed in or in certain cases to an electronal discourge in a victim title, is called the reserver? It is last extitated by fluorite, from which the phenomener gained to name. It is, if a beam of write aget be passed through a const of constess flavor to a delica a visite color Is called out in a path. This effect a chilly don't he retion of the other vised rays, and as removed with a change of refraight day in the transmitted

hulit.

The electrical discharge from the neg two pole of a vacuum tube calls out & let land by reserve not cale will, the dixnon- the ruby and marry gens, but saywe real measel the material Such anatabees may continue to contagor or physologes a toy the selectic crosses,

378. Phosphorescence - I be continued or exact of light by a substance (r at aneand sea to printiped report of y after heating exposure to aight

or to an electrical cascharge, a cut of paragonia reserve

Pluorite becomes legitly phosp reserve after being heated to about 150° C. Different vary besigner off against didd rent volume the thorough no variety, an enemal greet light others purple this and residish ties. This phose recessories it is but served it is there to be by sail jesting the pulserizer. moveral to a heat below reduces. It may by in he grad cost by a sharp hilly with a han mer So, to varieties of white transport or murble, of or wight hearing court a victor light, so also them a c, de buer e, and other species,

The X-ray of there voled I gle wil produce phase, be reserved in which is kindsite, and some dismonds. The fact that whit and glean when express to ul root let light is made use of in testing the read as from a willow as open make certain the separat 1, his been come, see R. In a challast as cause

certain paper de to phosphorace as well a reand writter

I speame to the eight of the steept above very apparent phosphoresection with newly di energies our some species in section to be less the of the parties This property is a set stock but of or exposure to the black risk of the specific where in the rest pare it is ray by here. A maximum of each is supply in the burnath will phosphoreses for a considerable period after being exposed of minight

379 Triboluminescence and Crystaholuminescence | tertub "Pystale fixed substances become business when thebed or secuted of all spreperty. known as technica accepted as exhibited by some in a did creatula vor.eves of spinler to give of tight wher ser, thed logit has not ness go en off by certain substances in crustin many from a soluting Arseni oxide, As,U, is an example. This property is maind orgitalionaminescent.

# SPECIAL OPTICAL CHARACTERS BELONGING TO CRYSTALS OF THE DIFFERENT SYSTEMS

380. All crestalized minerals must be grouped into three grand classes, which are he actually by their physical properties, as well as their geometrical form. This three classes are as full we

A. Isomo, I ask or bowing crystids of the isome rie system, which are

referred to three casts, reconspiller uses

B less on the test embracing crystals of the tetragonal and hexagonal systems refer to the toron, or three equal to record a second at the there or for the most of the time in all right angles to the rights. Crystals of this class have a bree, prove all as a of crystal propher symmetry.

that against the or leaving the crystian of the letter brotable, more-

class and trear esystems referred a those drag at Ars.

381. Isotropic Crystass. Of the time classes, the properties classes and describe trys at about will especial algebraic properties by the compact to the com

It is not be employed from he were that such a great is not multiple will be a read that expenses which had a discharge in the moderalist

gird for the sandaspit descriptions me Art 280,

For end or and some as gets and all who are described of any organization of any organization to be the transfer of the solution of the bly the source of the section of the best of the source of the section of the source of the section of the source of the section of the sect

also is nightly the ristra to male may priper a

382. Anisotropic Crystals, Uniaxisl and Burnal Crystals of the 180primer it and exposes in Crisisals on the other land to in a state of the state of the front a tracest significant and coming. Their price proceeps, or in general in the different area of star more particularly the vegocity with which light a propagated cares with the direct model and rather

Ingeform nor and of the cosh particle assitut arms in property of the lightest or upon which the accounts of propegation depends remains constant for all accounts within a merial terror for all these equily method to the account of the account of

tree also the latter amount of the case have more complex option relation requiring the above into the could in general minutes as a teached in the retter and a series are his choice and go is in character to the sange of the axis spoken of aneve, hence, these crystale are sent to be optically biasent.

#### A. Isometric Citrictals

383. It has been stored that crystals of the isometric system are optically isotropic and hereal igot travels with the same velocity is every date to the theory has been been by a care, herefore suffer only single refruction in passing into an

motrope medium, or, in other words, there can be but one value of the refractive mis x for a given wave-length. If this be represented by a, while V is the velocity of light in air and r that in the given medium, then

$$\mathbf{n} = \frac{V}{v}, \quad \text{or} \quad \mathbf{v} = \frac{V}{n},$$

The wave-front for light-waves propagated from any point within such an Isotropic medium is, as already at ded a sphere. The sphere, therefore, may be taken to represent the option properties of an entropic medium. Sections of a sphere regimal to any diameter will always be carees. These carcular sections with ake rada in all directions correspond to the fact that the optical character of an isotropic substance is the same in all directions normal to the line of light propagation. Or in other words, light vibrations may take place in mry direction normal to the direction of transmission it is, the light is not polarized. Further its velocity remous uniform no matter what may be the direction of its vibration

This statement bolds true of all the classes of somethe organia. In other words, a crestal of maximum aymmetry, as deorsto and one having ten restricted symmetry characteristic of the tetrahedral or pyritchedral cas a one, have also the same notropical argent. Two of the chases, however, namely the plage medical and the tetartoheard classes, differ in this particular that crystals beinging to their may exhibit what has already been defined. Art

356) as clesular polarization.

384. Behavior of Sections of Isometric Crystale in Polarized Light. In consequence of their is imple character, is notice ervet as existing no appear I phenomena in polarized light. As a section of an iso repic schetzines Carried the crystal or stone amorph at price at his no programs or double repracting effect upon night it diges is ton ingen. If the observer of light that enters it from the polarizer of a polarize pe. Therefore this sections of usetropic randor when examined in a polymer polymering microscope with the moots grossed will appear dark in all positions. In other words, hey are niways extinguished. Fortour, when a coord immera is examine, without the analyzer there will be no change in its solar when the section is reviewed with he stage of the increacepe. Some anonance are mentioned on a in sepage (Art. 441).

The single refractive today of an isotropic substance may be actern acd by means of a prism time Ar 333 with its edge out in any direction whatever

### B. UNIAXIAL CRYSTALS General Optical Relations

385. The crystallographic and aptical relations of crystals belonging to the tetrogonal and hexagon a systems are aready been briefly summarized (Art 382, if now recomes to develop their operal characters more field This can be done most simply by impacting frequent use of the far after core ception of a light cry to represent the character in I motion of the light was p

388. Behavior of Light in Uniaxial Minerals. - Light reperting a new and in norm is in general brokensu. The two pays which an pour zerous planes perpendicular to cash other and which cavel with iffer velocities and therefore have different makes of retraction. One of the two rays between from a single meadent ray weaps wit races as the plane of he horizontal eratallographic axes. The other ray vibrites at right angles to the first and always the a vertical mane that probable the vertical epistallegraphic mos-The option character of a man of man rates and orn for all direct his york in the birther il greated ographic plane or I therefore the my whose value the thirt of the total tree from the city to market what he mark the of most as in. It sims and therefore have a sugar and country to lay of refract to a money designated by we hance that they follows the usua, law as to the countries by with the sites of the angles of the letter at I refrict tion and a greend lateres in an opport ry was a cast of the regional way The ray with vibrates in a same that nel destity vertical erse if our inaxis while with direct of taxibrat is constantly changing on the direction of attitude to the age of control of the colorest of the of the col made very I smaller the right to wit applicate depend point the first in of its pre temperature and people in the greaters, show the useral same how this this is therefore a lord in extensional by any

When I g t track in a an axis, in and in a direction parale, to the vert a crystallography axes, enter all the tibest one grant time a see to be I might all more it occurs who by as the ord early the with a sit gar velocity telepotation and the Laro can be to for herefore to a fight therefore using this chief, the and in his case the new rule and behave one in in transwho doe can develop of he but when hop entroped wit the cor-

a restal acts orkings as the epe ar cane as then is care one such threeto the the set of graph is after sented as real. As some as the directhen of transposing becomes me med to the vertical error of axis the hant is mally refracted at all as the field the promises to direct a fall round of the right of the extra educary may departs here and nore from the plane of when an of the ord viewe y with a corresponding change in the veneral and retractive way. The difference between the refractive address of the two rule decimes a thermal a when the light proper the glober married as a her me of three tems with the direction of vibration of the extr or limits ray mars, all officer cal crystal axes of mother words as divergent as prospher from he languaged peaks. The value of the refractive uses of the extractiondinary ray where at its may mem sufference from be constant in lex of it. orders pay a the arealways quied a wead welling a less two process. was be are called the practical values of a star erest. A practical nector of a union occupial is not to passing the opt the vert was

387 Positive and Negative Crystals. - Lin and a crastale are divided rate two eleases depending from whether the year you in revening to my ris a greater or besthan that of the piersry ray. Those in which he refruct to this of the orders ray, we is see than this of the extraordinary ray a (a < c) are called positive. This is indistricted by quarts for which, for yel-

law sodium locht).

44 et 1:544. a = 1.553

On the other hand, if  $\epsilon$  is less than  $\omega$  ( $\epsilon < \omega$ ), the crystal is said to be negative \* Caseite is an example for which (for sodiam light,

> $\omega = 14358$ 4 = 1486

Other examples are given later. Act 391

<sup>\*</sup> It a bassat in reviewbering time in a mark note that the test vewel in the world positive and negative agrees with the symbol used for the smaller index of refraction in each case.

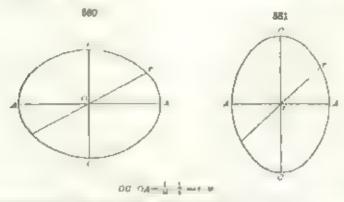
388. Determination of the Refractive Indices in Umarial Crystals. The indices of rest after of the arms of the per an elith same Wat as all the case of caste per said of as Will an expression is he werer. I prism or in to iset to a loss only of the or of the one 3 prists is employed, its copy spont, I is print a be to be any of the other we respect to the years of the state of a prism a example to be refree . by we retrace a toxic att seen, the stagles of refraction of what is be so west in other to be take I amount the distance the engineers make make the section to the 333. The warmes the the option, the course the patent of the format a plant and the expurcarrier not vil rating in the very contrade the face of a the edge of the the fight of strate a first is must be as renter by the agreed a meet press heat to most of the exceptor of his refree a ver Which the man file to a terrenty the first a transfer the others rule a file I was at 1 who is planted the time to very at one that of the extraordithree we appear for such he served by a residential and as possibly ruego to character a then, it, so set a west It is not at a to of an these trees where a fire worth to not crys all grapher or our top let could be at a croting there prepare not are so great that so I promo ute v ry a cop seed

I be smelled of a presented as seed a supply place to a suff to prince less it either can in the prise to be if the cream or the committee to In ract case two at come will be alwayed corn per again but position to the many on of total references how wereas. When we gete went parallel I a ther it the prises some to I these shallows, that is enging to the ordithere ray with remains of descert as he paste is got and on the horizon to pend the can refrugt carter while the broom of the extracel party may will care from being considert wit that days createry to be a order manuscrip three regions, from that position. This is ay is, in each region in position, which that send a greater or least glother at the general my depending upon The ptrin character of the married in he agreenessed ing to the true velor fithe refere or area for extendences my It is will be two pest sits at 180 spare chang the contacte process in fittings, shall which the value may be more and. If the pare was or there is to the based paris of the cryst of the two abmoons would both be abute nors a range such a revision to built he value of the angle for both mys can be operated it say position

It case the method of namerosco a bayods of known refractive indices in used, it is important if posses it to obtain the true values of wonds. In general, each interest group will violative indices currequenting to the two vibration directions indicated by the possession of extration of the grain. One of these it least will belong to the indicate rate rainary ray will value of a. The other maters while a long is to the extra minary ray will vary with the crystal ementation of the grain. It is series of variously emphasized sections, the materials are of indices and that show he highest ender of interference call is will give the closes apply to to the true. On the other hand grains that show he or poly a little breath general will give only the value for will a temperature figures see Art 397 can be obtained from the grains they will help on hear method as a finding the vibration direction of the extraordinary ray that wall give the index a

389. Wave-surface. — Remembering that the velocity of light-propagation is always inversely proportional to the corresponding retrictive index, it is obvious that the velocity of the ordinary ray for all directions in a unasual crystal must be the same, being uniformly proportional to have words, supposing light originates at a point within a unusual drystal the ordinary ray would travel out in all directs as with uniform velocity and its wave-front would form a sphere

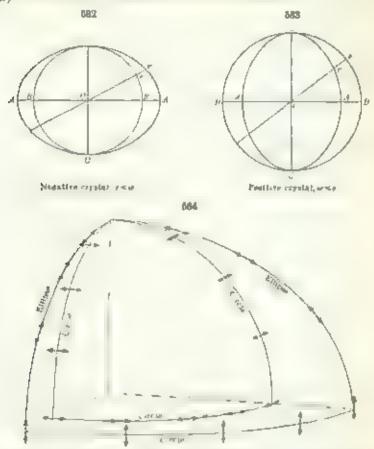
For the extraord nary ray, however, the vener to varies with the direction, being proportional to  $\frac{1}{2}$  in a horizontal direction and becoming sensibly equal to  $\frac{1}{2}$  when nearly coincident with the direction of the vertical axis. The law of the varying change of velocity between these varies,  $\frac{1}{2}$  and  $\frac{1}{2}$ , in given by an ellipse whose axes ( $M^{*}$  OA, Figs. 589, 581) are respectively proportional to the above values.



The wave-frest of the extra sometry ray is then a spheroid or an ellipsoid of revolution whose axis contributes with the vertica axis depends axis, in order axis. In the I rection of the vertica axis it is identical that the wave-fronts of the ordinary and extra country rays will contribute

Figs 582 at 1 583 to rest at version sections of the combined convessarious for both risk. Fig. 82 gives that for a new or crystal had a cate to we, the college of a section of the expendent risk of a positive crystal like grants to see with the class tall surface with a that is the sphere risk bid so an attempt to see with relating of the two sections of an gative crystal in perspective, it is single what I be constant value of the velocity of the critical risk (w), whatever its check of in the plane of Figs 582 and 583 is expressed by the risk of the circle the On the other hand, the velocity of the extra collection is given by OA (1), while it any can be direction as for high 582 fore, high 583, it is

expressed by the length of this time, becoming more and more nearly equal to  $OC \begin{pmatrix} 1 \\ \omega \end{pmatrix}$  as its direction approaches that of the vertical axis.



290 Unusual Indicatrix. The optical structure of a unusual cryetal cut be represented by an ellipse of of recolution called the indicatrix, from the bar as obtained the oriented of vibration and structures of refraction of the ordinary and extraordinary rays derived from any single incident ray but 555 represents a principal section of such in ellipsoid for an optically negative cryetal, the limit of being its axis. If no differ the axes of this carpes if are made inversely proportional to the indices of refraction of the two rays, is and a sa follows:

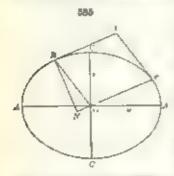
$$OC: OA = \frac{1}{\omega} \cdot \frac{1}{\epsilon}$$
 or and

The Uprical Indicasure and the Transmission of Light in Crystals, by L. Flatcher London, 1992.

In this figure let Or be a direction of training soon of light. Let Ve and VR be tatgents to the chipmen, so there it is points a right k and OR be a railing vector parallel to the training Ve. Or and OR then what are known as imaginate radii. From the geometric projectors of a chipse of fallows that the sress of any parallel grain with comparter of deriving seets less such as OLVe in Fig. 255, is a nation of a torque of the area of a parallel grain beyong VC and VC are that the categories having VC and VC are the state of VC by permanent in VC and VC are state of VC by the permanent VC and VC are state of VC and the specific VC by the permanent VC and VC are state of VC and the specific VC by the permanent VC and VC are state of VC and VC are as an VC. Let

$$Or = \frac{OAOC}{RA} = \frac{k}{RA}$$
; when  $OA = \frac{k}{cR}$ .

From the last expression, we see that OA and OF are uncorrely proportional consultation of in their words, as OA in presents the number of each other.



to resent the corresponding velocity of light which will be the maximum for any transmossion direction in the creatal. In the same way to will R be are inversely propertions, to each their the instance the representing the velocity of the extraordinary my traveing using that direction while R N will represent as refractive index. The line R N will also give the direction of valuation of the extraordinary my

Lather digited of the three of beauther possible the tion perpet in fact it and also noted to the ellipse of surface. This wild be a time from O period depart to the principal sector represents on the 5%5. This has a will be setter represents on the 5%5.

be in the horizontal executive section of the archester xield people with as length equal to 0.4 where in turn is provide up to the uplex of the manager may be so, for a given direction of creating soon of light with as 0. The two horizontal archesters with a direction of the surface of the archesters with with the archester of respect of filter two rays and the directions of their vibrations.

If, it we ver, the light is passing particle to the principal axis. I the indication, i.e., C. C. big 585. Once will be an intuition in bery of case which are perpendicular to this careet in and a the same time normal to be surface of the indicators. These will be a time borner that so the section of the chipsoid and consequently will be a time borner engil. From the it is evadent that such a transmitted ray may a brate in any emissions direction and will present a single and a direction and a very the day the direction of the light.

201. Enterplan of Positive and Negative Crystals. The Character hate give prominent positive and oughtire what is reached with the more of the red days to near a not a formation are stated as a superplan of the locate reference in a supergraph of the formation of the locate reference in the major of the locate reference of the contraction of the power of the contraction of the power of the more of the major of the other, and consequently for some color between the two extremes has no domate

zettsprlation. три скорь

The same is true for some other species e.g., chalesate) of weak double re-

### NEGATIVE CONSTALS

Primalific	2-171)	2.711	0.268 0.172
t attended	1 4 34	1.0.20	0.015
Cortacium	1.765	1 203	0.30%
De s	1.250	1775	×1696
A remarkable	1.720	. 715	0:10.5
No am to	1.512	h > 1 <sup>M</sup>	0:004
Apart to	[ 445]	1 631	0.003
	Гоздум Своч	ALA	
11-1-0		.e0	0-247
C no depth	1.997	2.003	(5.43(10)
Zarra	1 /2 1	1 868	4 45
Hear te	1 ,,744	1 50	1.1.23
Pher seite	1.94	1.670	pellah audu
Quarter	1.644	1 553	0.000
F .	1 576	1.509	0:003

## Examination of Universal Crystals in Polarized Light

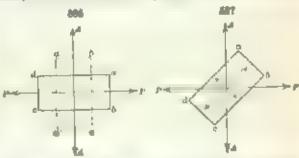
1.50%

292. Section Normal to the Axis in Parallel Polarized Light. pose a section of a amaxim crystal to be cut perpet hencer to the vertical ervet disgraphic axis. It has already been shown that light passing through the create, in this direction suffers no do if is refract on, consequently such a accord examined a parallel progress light be saves as a section of an iss tropic substance. If the meals are crossed it at peace dark, or caling asked, and remains so when revolved.

393 Section Parallel to the Axis . A section cut parallel to the vertira axis, as alrea by explained, has two directors of hight-vibration, one parallel

to this axis, that of the extraordinary ray, and the order strigger anglew to it, that of the orat hary by A buy of light folling upon such a section with perponde lar presioner ja titvaled arte the two rask or Loary and extraor dinary, which travel on in the same path through the crystal,

areas to



Lit one of their retarded relatively to the ther. When such a section 8 ex mined in polarised light with crossed needs it will appear dark or he extorgunal od when is cilmation tirect as he para of to the vitration directions of he meds. Assume that the section and hig 586 was with the arrest on of its vertical crystallographic axis paralic to P.P. which represents the vebrat on direction of the polarizor. The light entering the section under these conditions will be vibrating pursulal to the vertical axis of the crystal and will there is pass into the makes which as the extraordisary row to combeing to some on possible 2, be described of the editors for the fight will, the notice makes the second of the editors for of vibration as when it created and we be entirely and by make though the adultation of the section is turned at an argument 00 as of a filling 1900, and had redults as prevail, at left if the exact the tight will the section as the ordinary ray thought a make a section of the processors of the distribution of the exact the stage of the processors of a cross-powhere it will be exact thousand.

If the section stand of the last in about it by \$87, will appear light to the excent boundly section for the constraint parties of the \$1 P that have present through the polymer has taper too about a component in the correction of each of the restriction again each of these components can be seen to be given a stand of the section. Again each of the appear a col. A. A. Therefore, we may will energe from the arrival both to his he so, we also a provide the arrival to the arrival to the arrival to the arrival to the transfer of the arrival to the arrival to the arrival to the transfer of the section. In general, therefore, these parties of the section. In general, therefore, these parties of the section is suffered at referre these parties, in a fine direction of the section as suffered to the the transfer to the parties of the section as suffered to the the transfer to, of the section of the section to the arrival to the the transfer to, of the section of the section to the the the transfer to, of the section of the the transfer to the transfer to.

394. Parallel Extinction. When the vibration directions of a section coincide with these of his programmed analyzer, used any the training of the research the section, as a graph is directly as a property of the research parallel and parallel and the research parallel and the r

show inclined extraction.

In the case of started in the day since the differential was a ways need to some extension of such manufals we show

parallel extinution.

396. Determination of the Relative Character of the Extinction Directions of a Given Uniaxial Mineral. The instance characters of the extinction provided the second of the second second of the second second of the second second the second second of the second s

396. Interference Colors of Uniaxia! Minerals. Basefringence. The interference course of any section of a mask that the depends apon the figure of the section section upon the average of the section section upon the average of the section of the two retrieves the property of the first control of the two reasons the average of the first control of the two reasons the section of the two reasons the section of the section. A second control of the first control of the section. A second control of the two reasons of the section of the section of the section of the section. The second control of the two reasons of the section of the section of the section of the section.

emphisms remaining deform it creases as the meliantian of the section to it. Justal paste more sec. The highest cretralgence of a given intests as therefore so we by its present our sections.

The following table? gross the tracktosse in infligators of sections of a

few to main, crystals watch yield red of the fire order

	Diself opened	Theknow in
Rutile	0.257	0.0019
t actr	(1 × 7 %)	0.0033
Z	tr to 2	0.0089
Lournship	0.021	0.0240
Distriz	G H30	0.0612
Nephelite	b 004	0.177
Leneste	0.001	0.5510

Agency, an arcelling expension of the second columns in heart groups a ... to the heart group of the heart of

The notion of at a most to determine the treefs against if a section of a section of a section of a section of the section of the two sections as the case of the two sections as the case of the two sections as the case of

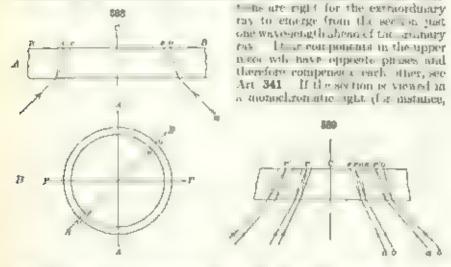
mittend, were outer agreen, see hers 353 out 354.

397 Effects of Convergent Polarized Light upon Sections of Uniaxial Minerals. Umaxial Interference Figures. Which corr no sections of the non meterals are observed in convergent potential light has show with per known is interference unices. A symmetrical interference figure is iltrived in times of immerials by allowing to averging policized light to pass then ghis have seen in of the crystal. Parado polarized gar entiring such a section would suff a to constar refreet and a new point a give a conterformers. I second ser the paracel pour zeal figure that is now from a pour zer the convergent high a case pened between the polarizer of the sic of Under these conditions a secondly converging core of light rival enters the porter to Attentive can as present almost the second to observe these managed the back og meinte a par i posite a Siel an instrument a shown as a on scope alons a Landly proughful forests were the paper or and anniver of a pel pracepe or at case the pear ough price per a med, the stead converge gleen that residence the powerset peaking the passe on his B he are and by the same type a six on least are two as the Bertraial Cas is its rethereof who the processing title

In fer such constitues the split entring the section is composed of a converging section of two polythed and whiching in the plate P. P., Fig. 588. Let B. R. Fig. 588. It be a vertext ences section of two action section and the hear R. R. Fig. 588. B. It be a representatively as the tring the section of a polythed at the triple of the section of a polythed at the extracted into the form of a contribution of the two cases as the legal interestic section in the form of a contributions of the two cases as the extraction of the form of a contributions of the two cases as the extraction of the two cases and hear a star by Eng. 580 apone on bother. Read to contribute and hear a star by Eng. 580 apone on bother. Read to contribute a doubly refrected and polythed this the two cases as doubly refrected and polythed this the two cases as a doubly refrected and polythed this the two cases as a doubly refrected and polythed this the two cases as a doubly refrected and polythed this the two cases as a doubly refrected and polythed this the two cases as a doubly refrected and polythed this the two cases as a doubly refrected and polythed this the two cases as a doubly refrected and polythed this the two cases as a doubly refrected and polythed this the two cases as a doubly refrected and polythed this the two cases are double to the cases and double the cases and the section at the cases and the cases are double to the cases and the cases are double to the case and the cases are double to the cases are doub

<sup>\*</sup> bee further, Rosentsuch (Mikr Phys. Min., 1904, p. 292 from whom these are taken.

points can't Ray bulse on entering the section is doubly refracted and polarized. Suppose the extraordinary ray derived from blemerges from the section of the same point as the ordinary ray derived from a, that is at resident it travels with a greater velocity the extraordinary ray an erging a this point wit have advanced in its phase over that of the ordinary ray. In that case they want if he is a continuous to mere with each other except that they are vibrating in planes perpendicular to each other and so entinot. The two rays travel on, vibrating in planes in righting as to each, ther are maintaining this difference in plane into they reach the if not most there they are each resolved into rays vibrating in the plane A. A, h.p. 588 B, and not condition to macriery with each other. Let it be assigned that the condi-



sodium light this interference will result in , these point. But as these rays are enverging in the form of a contithey will make when they stake the section is circular trace apost its surface and their interference will result in a clark rang. Going out from the center of the section there will be a succession of these rangs corresponding to the interference of waves 1, 2, 3, 4, 5, etc., wave-tengths apart. As the distance from the center of the section as increased, we piths of the refracted rays in the section are length-med and the parts of interference are brought closer together. This will cause the interference rangs to be negative as the distance from the center of the figure increases.

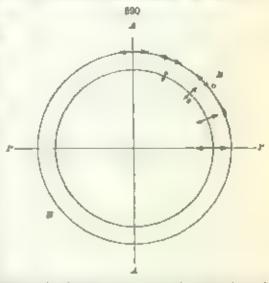
big 500 is a top view of the section without taking into consideration the effects of the upper accol. Let the two circles represent the cases of the consequence of the two cases as be into which is measured content as shipped, c, being the less retracted (for calcite), will be the union one. The plane of vibration of an always paralle to some plane passing through the vertical axis of the crystal therefore the trace of its plane of vibration of one at right angles to that of the extraordinary ray and parallel to the borizontal axes of the crystal, therefore the trace of its plane of vibration

upon the surface of the section will always be in a tangential direction, see Lie 500. Arms the line P. P. Fig. 500, only light identing in a radial many or and of the extraordinary ray can come through the section, since the ght outering the section cannot be resolved into the vibrato half the ordinary The intensity and direction of vibration of the light that emerges from the section along the line P P is represented by the double are won that line. A grad to line A. A. since the right entering the section is sail vibrating in the prane P P, all the ogit passing through the section must vibrate as the or phart ray It is explicit, therefore that mong these two directions, P-P and A. A be plane of a brotion of the light is not changed by passage through the secure and consequently such light will be completely absorbed in the if per tited. In this way think better is with be formed along the lines P P ran A 4 These dark wess along which examption occurs are known in

be the the managed and be send interference ligures, us rac-Queen. A dark spot will also be formed in the center of the field because any light entering the section at this point must enter in the direction of the optic axis and therefore we not be descrive refracted and conseniently will also be absorbed in the

BIGSTON

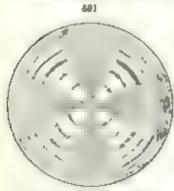
Now consider point B, Fig. 390, which bea 46° away from I and A. Hure the directions of vibration of a and o would be equally inclined to the planes of vibration of the polariscope, A A and P-P. Light striking the section at B would be viorating in the plane P P but by



resolution a component vibrating in the directic's B B would some through the second as the ray e, in the some manner a comprehent vistaling in a firection at right angles to B B would emerge us o. The intens has and divesthough of vibration of these two rays at this point are represented by the double arrows. When these mys meet the analyzer above they would again each be reserved and their components which vibrate in the plane A A would emerge from the analyzer. In the way it is seen that, except at the special points where complete interference takes place light will result in the interference figure at all points away from the center of the figure and from the hoes P P and A-A. From the consumeration of Fig. 500 it is evident that the greatest amount of light will come through the section at the 45° points, such as B. When viewed in monochromatic light, therefore, the interference figure consists of a some of concentric cark and light rings crossed by a vertical and a horizonial derk brush intersecting in the center of the field of the nucroscope, like Fig. 501

If a panni section of a uniaxisa materal while in the conoscope is viswed in

the light eclosed rugs will take the place of the tight and dark rings observed in the tars of romass cight. The change will a new that so withly be a curta weage in the summer case described in Art. 349. Where the first few dark is a near the count of the figure were torned by he interference of rows the cight of so the light of orange or ready or confirm the facight for the first of the structure of some particular ways to read that the self with some particular ways at gith of light. While the interference of some particular ways at gith of light. While the interference higher when instance of in the light of light while the interference higher when instance of in the light of the count is a light of light. While the interference higher when instance of in the light of the counts of the counts of the counts of the light of the counts of the counts of the light reservance.



I make the testerance hagain

increases, has be morgen to the white of the higher ribit. This is due to the everlap, my of the anterferies rings of the vary as a copy in the same analysis as beeved in the quartz wedge see Ar. 349. The interference by are viewed in taying with will of course total the back research curter since these are legally the cutting on a fall the sight by the among year and the cutting of the same land to effecting.

The day once of each successive ring from the center of the interference ugues by one as the per la upon the larefragence of the difference tanager the refrictive in free for the size for the size for the size for the size for the party for an use of the late atmospher the death, retracted and he thicker the paste, the six closure was he

will give a cirtuit amount of ret read or a more worse in he are the circles will be to the earlier. Further for the same section he circles will be accretion of a circle glob man for red or case of her shorter with singer William for the accretion of her shorter with singer between the circles of her shorter with singer bediefinedly seen.

398 Determination of the Positive or Negative Character of the Bire-

fringence of a Uniaxial Mineral from its interference Figure

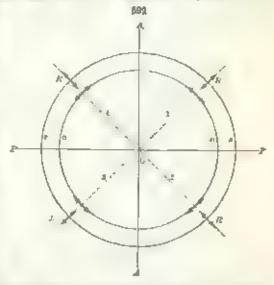
the of the Man Perte — but the den field to be under all mental in the fully inject and to determine whether the clear error of the leaving general positive of registre — rate can be sent to be set accomplished by teste as the upper the inject to inject the inject to the free parties of the two rates in the inject to the i

A-A the plane of vibration of the study ser of a concecope. Let O be the

point of emergence of the optic axis of a positive insexual mineral. Suppose a single educal ray of light enters the section. It is broken up in the not ral ato wo rays, a said a which energy from the section along the area of the circles shown in Fig. 592. The areas of the ordinary ray, a will be with a tot of the extraordinary ray, a, because in a positive numeric the army travels that a criminal spear refracted. The lightness of a brack on of these two reys at the 15 points R and R are represented by the double-beaucit arraws. When it we rays reach the studyest they said be resolved into compositions at taking part, elite A.A. There are an inhomormous as the rays entering an appear of a brack of a position varying lengths of path. At some circle with a difference of phase of one

whole wave-length and when resolved in the upper need into rays vibrating in the same plane will interfere with each other and produce the first dark ring of the interference figure as it is viewed in monochromatic light.

If the mica plate is introduced above the section a change in the interference figure a noted. The optical character of the mica cannot be fully explained at this point. It is sufficient for present purposes to know that it is a doubly refracting mineral which breaks light up the two rays which are polarized in planes at right angion to each other art which traveling with different vel-



or the through the rines, will coverge from it with different phases. As stated als we the mich place a occaved to the requisite thickness so that the two ruse emerge from a web a difference of plane of the parties of a wayslength. Unpotter what takes place when such a place is introduced above the sect to propose steel in Fig. 6th, in such a position that its vibration direction Z is a real 1 to the direction h () R of the Lyare - 4 opender what I have above at the months if There the vitest on Levelies of the eval corn loss with the company direction Z of the men plate. These extention directions in each con are those of the rays traveling with the smaller venerty. On the it er a d it, at the same point the sibration direction of the orange he mineral come, les with the viles, in direction Y in the parte, both of these being a the cays with the greater velocity. So at this point the effect of the new plate is to increase the difference of plane between a and claim to presence the sume result as if the imperal section had been thickened. Consequently the interference rings mong the line h O h are increased in number and drawn loward the center of the bigure. At the points & the o sposing is true. The Vitrat on direction of r coincides how with that of  $\lambda$  in the runes plate the

direction of less relocity in the miners; with that of the greater in the mes. Also the vil ration through a forcome desirable that of Z that of the greater velocity in the faithful was the less velocity to the oren. So at this postthey near will decrease the difference in phase he weem a and condition of the effect of thomag the ser on and so spread ig the adorference migs further spart along the rac R O R'. In quantrants 2 and 4, therefore, the range with by reason the color, while a quadrate formed bey walls reprodu farther out. Another effect causes by the months of of he more place is even your pres taken! In quarranta Land 3, is the down the strated in Fig. 582 black data we open man the center of the figure. In the interference fig to, before the a troduc aim of the quest plate, there were perios a qualit aits I and I at short doctanger from the center, O where he two rays, a or leemerged from the section with a difference of place of our quarter wave-length I i by these one, and a staterferon a could take place and these space were light. The effect of the mies piete at close two mondrates a everywhere to reduce the birefringence due to the influence by one quarter of a wave-length.





Determination of Optical Character with Mica Plate

Therefore at these two points the difference of phase caused by the birefringence of the numeral is annualled by the much plate are, consequently at these policia miera rence will resu t and black data appear. The mea prate produces st. bother affords. The trushes which were dark in the interferer to figure become light. Light corning from the erveted section along the lines of the brashes is v brating only in the vibration direction of the prairier and ordinamely to wholly cut out by the analyzer above that with the inica plate intervening this light is broken up in the mich into two rave which vibrate in the vitration planes of the mila and as these are no med to the plane of the army ser a port on of the light will come through to the eye. As the aght coming from the are on along the lines of the Lrusbes had only a sugar velocity (was noticely either the orditary or extraordinary ray) there are only two rays emerging from the in ca peate along these direct cas and their difference of phase is one quarter of a wave-trage h - Under these conditions there can be no inperference and whate brushes result. In the same way the dark center of the interference figure becomes light

Fig. 593 A is a magrammatic representation of the interference figure of a positive numeral as affected by the insertion of the mice piate, the direction

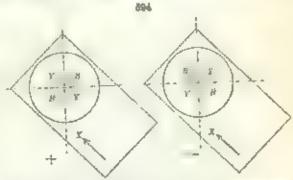
of the arrow indicating the direction Z of the inera, i.e., the dore on of vibration of the ray having the sinvier velocity. In the case of large we imperal the cer or has as described above with a compactly inversed. Fig. 584 B, my resents the appearance of an interference tighter the negative annumal when

the main patr is used

Therefore to determine the optical character of a shirt alone on the its interference tighten poerty in an appear above the section with the Z direction on any and with the vibration planes of the means. Then, if has direct to Z be at right angles to a line , at my the two block data that appear near the center of the figure (i.e., the two hires form a planeign), the interval is positive if on the concentration, these two directions concede (form together a minus seen) the material is negligible.

I se of the Secondare Tend The secondare that, see Art. 350, is used to determine the positive or negative character of a unaxial nameral from its anter-

ference figure when the mineral section is so thin, or the mineral posacesees such a ow fure-(magence, as to show us the figure only a objek gross without any rings. Under such conditions the muca plate would not give a decisive test. The sensitive tint is usually so mounted that its longer direction comrides with the direction of the villant on of the faster my, e e, the direc-



Determination of Optical Character with Sensitive Tim-

tion Y. The sensitive tint is introduced somewhere between the polaritor and amayzer in seek a position that its vibration directions are at 45° with the planes of vibration of the rice as Let it be assumed that we have the interference figure from a positive mineral, such as is represented in Fig. 592. If the sensitive and is introduced in such a position that its Y direction is parallel to the late R O R the A direction of the semantice tint will be parallel to the direction of substant of the etay is the materia. Since the material a positive the e ray will have the signifier velocity go, therefore in quadrints 2 and 4 the op eal or spitation of the mineral and the separative (a), will be opposed to each other. The sensitive that at me would produce an interference color of res of the first order. But if the propert of the tarefrongspee of the superil as such as to suptract from the lapsfringence of the secretive that the order will change to ye dow. Consequently in these qualitants we low spets we appear mean the content of the field at the peints where the effect of the emiteral has been sufficient to lever to interference color to that extent In the other quadrants I and I, the faster and slower rays of the numeral and sensitive that coincide in their directions and the effect of the two autobay es a an add tive ne Consequently in these two quadrants the color will rise to blue

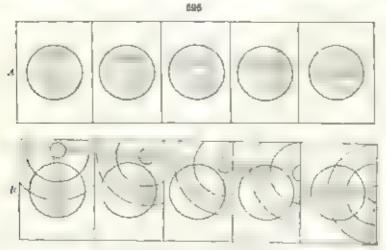
In making he shows test with the sense we that it is convenient to follow the rule that if the direction X of the sense we that crosses a line on ting the two blue data (makes a plus sign) the mineral is positive, if, on the other

hand these two directions coincide (make together a minus sign) the mineral

is imposited. These can bloom are it us ented in Fig. 591.

399 Interference Figures from Inclined Sections of Umarial Minerals.

It from an ly happens that a material section under observation for an interference by making exactly parallel to the basal pane of the crystal Armorfornee figure obtained from such an income, see on who of course be exacted to the macroscope head. If the section is much a long a bitle to the basal plane, the renter of the tightence is the point of emergence of the opine car will all be worth the final of casted and will move in a circle about be existed of the field when the section is revolved upon the puroscope stage big 505 A, shows the successive post one of success in terrference tighter little section is more sharply theliced the center of the interference figure may be quite outside the field. As the section is turned on the



becentific Undated Interference Equation

st. g. In law, rms of the interference moses will traverse the field in successful. They same easy recess to a lid as a rough once and provides the some chart per is cut to I too highly the worl to the plus axis will in we is puss the help maraling to the cross hars of he macrossipe. This fact is of an on once up per to is again, she is a attaxial eterl percologic from capture period the rece has after whatten at not account here which between and track to curve on this, cross the heal of the anjeroscope. If the less of these bore to the on exchange to very from left wright across the fig. the strate, wh to person the top to the bettone for it relations sail to left or the load from the bottom to the top, etc. I sg. 505 B, above the different posters, of part aby or biring our ministral resolution. If the service profits inclined to the ortheaxis the black bars in the figure walst aw some curva, reus they move wrose the field furning the petition of the section. They are cross the center of the field as atought tars to us parathe to eather the horito not or vertical cross-hairs of the mean scope but as they heat pour from view the end away from the optic axis, which will be broader and more vague

in is at inc, will curve slightly, bending away from the cross-hair to which the bar as a will de is para tel-

The positive is negative character of the appeal can usually be determ bod to read ecountric lightest cate is taken to make curt un which quadrant

he could when the less originate. For mot new, to but 5 to is shown how the test is made with the sensitive and upon the eccepture opterfer-

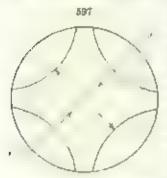
erse hime. I a positive numeral

In earth using unories toted sections of a mineral, a chi a the readon accions four in a roung ster con or the small fragily exits of a potential placed open a goods of legal to the all ways the there had see jon that gives the lowest purerference color. The amount of therefore govern out with the transite sections of is the study in a god becreases as the ecoty to pe proxides the oper tation of the basid paner Consequently that seem in all isting the lawest interport or culor will will the most near a avnous tried interference figure

400. Interference Figure from a Prismatic

Sensitive Tirt with ha sected Interference hardre

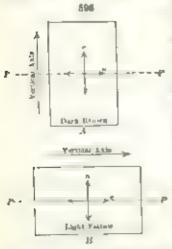
Section of a Umaxia, Mineral. When a prism of a section of a superior time. it is examined for an uncoference figure the rest. In a figure which of anningers to be housed a the case of larven crystals. The regards of t a resemblance with a pointed out in a reportable I'de two types of the en caract la notas case easily inferentia ed and lake and really a definite by sertungs apprendiction by there as the section is correct at the section



some stage form at a shart cross, and cap at soprate and heappear but this reason in lighte and ten en all a than Lighte Dans ters differ from those obtained a an orders balks, at empress figure at that they remain for each me they increased from the cross to product these eagle are always refer as to the feel to the greatests will be to seconds a open as a fifth cross of A the past of fire and then extend the relathe it about a titlement is on its orthogonal to a proved special to that reduced as high fig. The end record place of the direction of the direction to es of the arrows of ma a the figure - in goe, the besture ( ) we beaut

there appears on enjoying the treat in the contract of the theory in the contract of we program the er serve the head that is possible a made notice to serve tages the late been on the epic asserts by common not by by the a man are parentially the posts value per of the plant and exercipating the contract of the contract of the state of the state of the contract of I just be or it agreed towayer the confine on it is the latweep the figure and a solutar one of amost from cert in sections of a circuit crysial er Art 417 and type of amand figure can be easily of tames if in the quarts wedge.

401. Absorption Phenomena of Umaxial Crystals. Dichroism. When light enters colored in zero as rays of whate light, i.e., continuing vibrations of all wave-integers from that of viewe tight at one end of the spectrum to that of restright at the other certain wave-lengths will be absorbed during the passage of the right tree go the mattern so that the light as a color of the right tree go the mattern so that the light as a color of the attended and character of this absorption depends up to the direction of the agost vibratist. For distinct in he asset of maxima informs, the ordinary and extracrements rays may emerge from the section with distinct a different color. These for distincts, a present a section of a brown control to animaline in hobserve it in plant position light without the use of the 1 per nicel. As the section is represented a light years brown. The greatest difference in the



color occurs at now a use 90° spars of Livings the crystal ographic irrections of the section, i.e., the yest, on crystallographic axis and the trace of he id me of the hemzonica axis are of igr para lef or perpendicular to the silication plane of the polarizer. In other words, these extremes of coor occur when the directs as of the vertice of the ordinary and expurentary rave of the section are porable, or perpendicular to the vibration plante of the highles terms the section. In lag 585 A, let P P represent the v bration direction of the ight catering the secnon. The nuneral section is a absent that the describe of the vertical crystal axis a perpende bar to P P. The light on entering the section will therefore vibrate in the putar of the longertal axes or no the orderery ray of the position the Lournahot section 8 lack courses and expect tently it is seen that light sibrar g in the numeral agethorardinary for at

largely absorbed. Now that the section through 0.00 and 0.00 to the positional own a big 50% H. In this position the light mast value on, the section which as the extraordinary ray, r and he color as a light q by by brown. Therefore the extraordinary ray is only sughtly absorbed. This afference in the absorption of the color of the two rays is known as decreased. Fother the ordinary or the extraordinary may be the initial section and the two rays in at the initial sections and the two rays in a better in at absorbed and the two rays in at the initial sections and the two rays in a better in at absorbed and the two rays in the trace of the color of the color of the color of the section r is the first two rays and the section r is the less observed in prior the such as where it is the first of the first of the section r is the first of the section of the part of the section r is a sum and belong wholly to the statisty ray.

Approximent called a distriction of continues to Hardinger in manifolds quest for exampling this property of crimins. An in a grind to extend of Lemma apartic placed to a metallic viladrich mer, has but a min a lemma one of a min in a mer has at the other on backing cornect of the state how at each of the other to the extend of the state how at each of the other manifolds of the extendity of the content of the extendity of the content of

difference of color is percept ble. A similar device is similar ned as an order in the

Balance Street, Mrs.

402 Cucular Polarization. The enjoyet of respicant a peared gift and envisar derive as go for an or derivation twinting of the thou behind to trayer decreases that is a first it short

The board of the way to deep the second of t the property of the rotation increases with the second of the rotation increases with the second of the rotation increases with the second of the second of the rotation increases with the second of ed in converging pole cer a to it outside the interference and exhibit an analysis of the space with the space than a name cases this ename is come to be left, the first is larger and the enter the cases to be left, the first is larger and the enter the cases the cases to be caped and the enter the cases the case the cases the case the cases the cases the cases the cases the cases the case the cases the case t the species also that introduced a chain A to a sparate " I to a strong at

403. Summary of the Optical Characters of Uniaxial Crystals. 411 eper to all divinal cracking all and the reference to exceed these than the cult particles to total process of the manager and section which particles. to the Where we are a remorphist particularly that her moved bear with me new above a characteristic as a state return by receive these that so on let , stall general section of the tells a girly religion but File A coulty felt in greater up have two to the an are from compression ! ing to the two a terestee terms come I there is any a seal by there in a time a many of free a me dependent on the secret of the sec of the the part was a three politicands on a star for an intropy nto taxing it substitutes at but by his ignary from in 1 they by an if rate 1 5 may in al lines the apart by confusionality chain sections of their crystals.

### C. BIAKIAL CHYSTALS

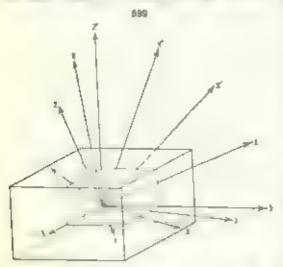
### General Outroal Relations

The crystals of the repeating waterns are the giber of the momentum. and true is to be just to a series where to be an incomp

404. The Behavior of Light in Bianut Crystals - In beautiful there are three especially in pertain alone into it right might center cach it er with any angester as I I and I am & bear I I can three I necessary the syntax of a speker of us took of time by in retenance to orginal

<sup>&</sup>quot;Ares the new one if a next however showing with the uncremeper the lark crossof an oromary dispasse crystae.

seemed differences in the alter along them. The paties of these three differences are follows: Light which results from velections parall to A exterof greatest clusterity) is propagated with the upix, namivel and, that from a lattering patient of a Z to as of least close at a way training am velocity and but trong vitral one pain, elite Y which are intermed at a Min I to do be or in research that these current one, A, I and Z refer to directions of vibration at the A to interface of propagation of the corresponding to the record on the research distributed respectively as a, B, and by teaching a congruited as N, N, and N, and these and the teaching of the respectively as a, B, and by teaching a congruited as N, N, and N, and these as one and y bronging to tight with the manner of electry will be recorded to the control of the control



value of \$\textit{\$\t

In studying the propagation of aght within a brazial crystal let it be assumed that I g 330 is presents a rectangular parallelepaped in which the front to back axis is the direction X, the left to right axis in Y, and the vertical axis in Z. In

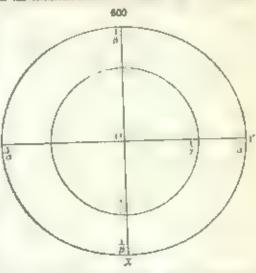
contiction with to figure and these when follow it is a light of pakense of a radial appear and low would prove research of a training from to each to each to the first two pakens are a lifet right or at the each to each t

In we derivate that follows it will be overlied: , this the greates at he center of a cream O, any fills, on the cream will be a make a local trade of the character of the crays which middle from O at a chirecter of the local which in recitive me the most proportion, and the characteristic fills figure, \$100 and \$100 and \$100. There will be considered first

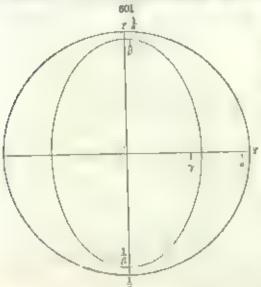
directly retrieved to the to the second breaken breaking of the glat (e.g., ) and Z, that for respect the these in shore

Consider the plane of the Y and Y directions, Fig. 509. Light will radiate from O toward Y and Y and in all intermediate directions with vibrations

parallel to Z and hence traveling with a uniform and at the same time minimum velocity. 1) The distance such agist will travel in a given moment of time may be plotted by rawing a circle about O with the rathers 1/5, Fig. 600. In the direction OX il we must also travel a see not polarized ray resulting from vit rations parallel to Ol' house travels ing with intermediate vebesty 1 8 Likewise in the surection OF there will be a ray resulting from vibrations parallel to OX hence traveling with the maximum to velocity I a In ad directions atermodiste between X and Y the light velocities will be



proportional to the radii of an ellipse having  $1/\beta$  and  $1/\alpha$  respectively as its semi-inner and semi-major diameters, Fig. 600. The the plane of the A and

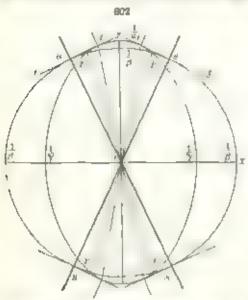


I' direct one, therefore, in a given moment of time light will called from the or iter as order ary and extraordinary rays, the wave-fronts being represented by a circle within an elipse

t onesder next the plans of the ) and Z care tours Fig. 500 I subt will mattate from O teward I and Z and in all intermissante caretania reredting from vibracions parallet to OA . It will therefore travel with uniform and the maximum velocity, 1 o. The distance traveled in a given men eat of tane may be plotted by drawing a caree about O with the radius I a, big Likowise there will travel in the direction OY a account my resulting from vi-

brutions parallel to OZ hence moving with the minimum velocity,  $\Gamma_{Y}$ . Also in the direction OZ there will be a ray resulting to in vibrations parallel to OY with the velocity  $\Gamma_{Y}$ . In directions intermediate between  $\Gamma$  and Z

the light velocities will be proportional to the radii of an ellipse having 1  $\gamma$  and 1  $\beta$  respectively as its semi-minor and semi-major diameters. Fig. 601.

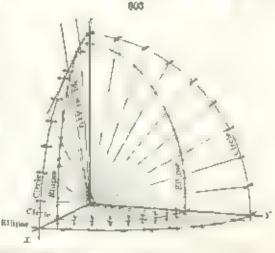


In the plane of the Y and Z directions, therefore, in a given moment of tone, ligh will requate from the center as ordinary and extraordinary rate the wave-fronts being represented by an olippe within a girole.

The last and most important plane to be considered is that of the X and Z directions, Fig. 602. Light will indiate from () toward X and Z and all intermediate directions with vibrations parallel to OY, bence traveling as it a saferm and intumpediate velocity, 1/8. The distance traveled in a given moment of time is represented in Fig. 602 by the circle with the cadius 1/8. There will likewise travel in the direction OZ a ray resulting from vibrations parallel to OX, bence moving with the maximum velocity, 1/a.

Also a my will travel in the agreeting (1) with a brokens pair. I to OZ overce having the intransant security, I a. In intermediate positions the agait ve-

locaty will be propertiers. to the mail of an ellipse with 1/a and 1/7 respectively as its semi-major and semi-minor dameters, Fig. (H)2 In the plane of the V and Z direct one, therefere, in a given in most of time, light will be date from be reister as ordinary and extraordinary rate the wave-fronts represented by a circle intersecting an eripse. If at to be to test that in this and place there no four points where the two wave-fronts come is In other words, ogh travestide already the radia, litter connecting these possis



will be moving with uniform valueity as I consequently along these directions. These directions are known as the optimities of the organism and since there are two of them the optical group is spoken

of as banual. The character of these optic axes will be more fully developed

in a later article.

In the above puragraphs the wave-fronts for light to ving in the three principal optical plates of the cryshall as a bette discussed. Fig. 603 represents the way stronts in these three planes as they appear where learning one stant. The complete wave-critices for again propagated in ill direct as considered warpest figures which contains to be open at all direct as considered a variety of secreted in the three principal in mes and base in module possible discreted in the three principals.

surfaces is by means of a model.

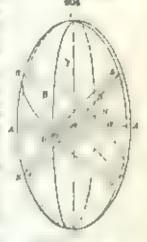
405. The Fresnet Ethpsoid. The study of the behavior of light in biggins cristile, especially from the math math above algorithm of view, has set greatly facilitated by the conceptions of two edges in so, he knowledges the Fresnel chosend and the bletcher intention. The freshell chosend for vibration we entire the bletcher intention. The freshell chosend for vibration we entire the bletcher intention of which are made properties at 6 the vibraties of ghoving the angle of properties to of vibration of any ray of light process through the crists of a vidration of any ray of light process through the crists of a vidration chosen in passed through the crists of any discussion of the two rays which can passed through the crists of such an elliptic view of the velocities of the two rays which can passed through the cristal in a direction from the chosen prime. Further to such at a hipsonic steps withe two sections that are circular in outline. Since all the radii of such sections are

repail, light passing through the cross of in viscets that cannot be duffly rescribed or pour sed. The circular sections of the breaked ellipsion that the second officer is the second ellipsion that the second error of the crossed ellipsion that the second error person to durito what are less what the second error person to durito what are less for the crossed ellipsion further Ar. 407.

406. Bianul Indicates.\* It is found for her that the optical structure of a becamil cryste can be represented by an edge-oid, at two as the rate at right angles to each other and proportions in length to attend these as a Thorough goas to the so starting refer to a result of the solutions and consider and the solutions.

This element, whose says represent in magnitude the three principal refractive nations, if it is the three  $\alpha < \beta < \gamma$  (see Fig 601), not only extract the caracter of the optical symmetry, but from it has be derived the vibration of any lightest traversing the exactly

the general any second through the indestret will be an elliptical section. The rot, it and more

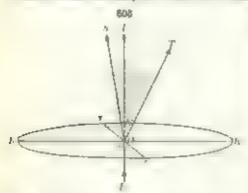


Binker Greenstrik

dameters of such a section will yield the list as and planes of vibration of the two possible rays whose wave fronts he is his prime or in other words whose wave-normals connected to the line purposite as to the section. If

<sup>\*</sup> L. Fletcher The Options Indicates and the Transmission of Light in Crystala. London, 1892.

the section happens to be one of the three principal sections of the indicative ABAB, ACAC or BCBC is good, its important and their lengths the indices of retrict or of the two rays. If the carment ray because the entropy and the derivation of the director of the two refracted rays is to a semi-provide derivation of the character of the two refracted rays is to a semi-provide derivation of the character of the two refracted rays is to a semi-provide the major and major cannot excit it BCB at the 4CCB of the rapid section has in the years of the two rays but the detections of variation of the fatter will be somewhat the semi-provide at the points of the rest by creeting norm as to the surface of the indicative of the religion.



that surface. These normals RN and rn, when extended to the into L. L. vield the kneed that of view-tion and the refractive instees of the two refracted rays. Their directions of transmission (the lines OS and OT) will be perpendicular to these to rivels and since neather of the latter lie in the clop tool sec. I. with rively will be refracted and belonge as extraordinary rays.

There are two special sections of the indicatrix that require notice. The line B O-B (Fig.

60% is longer than the box A O A but shorter than the line C O C clarity, in some pass of intermediate between A O A and C O C there will be a transfer of the ellipse ACAC which wid be equal to eight to B O B. There are two such that as S O S and S O S in Fig. 60.1. The important of it is a section of the indentria, BSBS and BS'BS, are equal and he seems therefore become crosses the section of these crosses of these crosses of the crosses of these crosses are the section of the indentrial to either of these crosses are set of a section of a cross of a crosses of the crosses of the problem of the crosses of the crosses. These areas consistent what are known as the primary optic axes of the crosses, see further in Art. 407

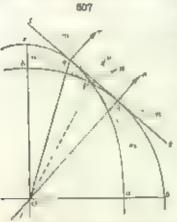
The major and manor discreters of any section of the indicatrix yield the traces upon that section of the planes of vibrations of the two rays whose wave more deare perpendicular to the section. In other words, the major and major dame era of the chapters section of the indicatrix give the directions of extinction directions beset the angles made by the traces upon the section of two planes, each of which includes the pole of the section and one of the two optic lines. This may be demonstrated by mid of Fig. 006 which represents a general elliptical section of an indicatrix. A A and B B are the major and major districters of the ellipse and so represent the extinction directions of the majoral section. C C and C C represent the intersections of the two circular sections of the indicatrix with this elliptical section. As these lines are

channeters of equal circles they must be equal in length and x therefore follows from the gettie rich nature of an eclipse, but the ranges A(t) and  $A(t)^{t}$  are equal. Let the true P(P) represent the intersection with the complication of a plane in which he the normal to the section and the x- be epitic uses.

some this plant montes an opic axis it hads. be perpendicular to the circular section of the in-heaters of which the line ( " as a danneter Also since this plane is a less is normal to the clique al sect on the et come teration at must be a right angles to the latter plants. Under these regulations it is obvious that the lines P Pane ( C' in Fig fast mast be at right angles a each other. In the same way I can is or red that the lines P P and C C are also at right angles to each over Since the angles Ath and 408' are equal and the digites a PUC and PUR' are also equal a follows lost the angles AOP and AOP are likewise equi-In other words the lines A 4 and B B repreger and the three-times of extinction of the sectien based the ingres made by the traces then the section of the two planes which respectively pass the 1gh such oper toxis and the normal to the ser out. Thus by t on the made use of mur see Art 417 in expining the clarautors at the based inserference figure

006 A

(Azt 406) that there are two directions, rangery, those normal in the arguing cross sections of the indicators (88, 88, bug 604) which are of such a har-



acter that all light having he wave-normale parallel to them travels in the crystal with uniform velocity. These two erset his hear so close so among to the optic axes of a uniaxial crystal that they are its called optic axes, and the crystals here considered are hence named brazial. In Fig. 602, which represents a cross see non of the wave-atriaces in the plane of the X and Z carrett is, these optic axes have the director \$5.5.5 across to the tangent planes \$6, \$67, as I the direction of the external wave is given by the normal \$6 (Fig. 607).

Property speaking the directions mentioned are those of the primary optic ozes, for there are also two other so nave at an ilogous directions, PP PP, of Fig. 662 called for the sake of distinction the secondary optic

axes. The properties of the latter directions are obvious from the 6 Lowing considerations

to the section of the wave-surface shown in Fig. 602 also cularged to Fig. 607), corresponding to the axial plane XZ, it is seen that the circle with radius

Intersects the edges whose major and minor axes are and 1 to the four parts P. P. P. A corresponding to those dates in the x-nectival preparation of the corresponding to those dates in the the corresponding to those dates in the the corresponding to the set of the corresponding to the set of the the corresponding to the co

400 Interior and Buserior Consens Refractions — The tangent plane is the wave-outland.

Interior is a to the set of going to the set of the mean of the same of th

409. Optic Arial Angle. Binectrices. Positive and Negative Binxial Crystals. The pair races on axis by in the pair of he X and Z optic directors. The pair of he X and Z optic directors is also because it the axis I should be been as a major image kings as a second of the pair of the axis I should be a second or other in the control of the influence of the axis of the first of the axis of

<sup>\*</sup> The axial angle was reput (4) when One andrew satisfy the following equation

occurs it is true for light of a certain color\* (wave-length, only and not for

others.

The X and Z optical directions based the angles between the optic axes and are therefore known as bisectricis. The one that bisects the neutrinial and angle is entired the order bisectric (or Br., while the one bisectric is used above without special qualification it is always to be understood as referring to the neutron bisectric.

Littles X or Z may be the scute bisectrix. If A is the scute bisectrix the substance is said to be optically against, while if Z is the active best fix it is

opticado positive

Recapilly expressed the optic axes will be nearer to Z than to X—that is, Z with be the basectrix—when the value of the intermediate in ax, S, as nearer to that of a then to that of  $\gamma=1$  is obvious self-lig 002) that in this case as the range diminishes and becomes nearly equal to zero, the form of the elapse of the approaches that of the project sphere of d the positive unweak crystal as its again leg 583 p 285. This sales the appropria chess of the sign here used

On the other hand, the optic axes with connected  $\lambda$  than to Z—that is, X will be the bisectrix — if the value of the mean index d is nearer to that of  $\gamma$  than to that of  $\alpha$ . Such a crystal for which  $Bx_* = X$  is called a physically negative. In this case the similar the negligible that the ill psoid opposition the object spheroit of the near terms and crystal by  $SS_*$ , p.  $SS_*$ .

The following are a few examples of postave at disegn are because erystals

Suphrir Lucestell, Topan Barite, Chrysolite Aragonate
Hypersthene
Muscovite,
Orthodase,
Epidote
Axinite.

410. Relation of the Axial Angle to the Refractive Indices. If m a given case the values of  $\alpha$ ,  $\beta$ , and  $\gamma$  are known, the value of the interior optic axid angle known as 2V, see also Art. 418) can be calculated from them by the following formulas:

$$\cos^{1} V = \frac{1}{\frac{\beta^{2}}{1} - \frac{\gamma^{2}}{1}} \quad \text{or} \quad \tan^{1} V = \frac{\alpha^{2} - \beta^{2}}{\frac{1}{2} - \frac{1}{4}}$$

In the majority of cases, the difference between  $\gamma = \beta$  and  $\beta = a$  is small, and then a case approximation to the value of 2V can be obtained from the

formula tan  $V = \sqrt{\frac{\beta}{\gamma}} - \frac{\alpha}{\beta}$ . But in any case, the results of such calculations are usually not highly accurate since a slight variation in the values of the indices of refraction will yield a disproportionate change in the value of the calculated angle.

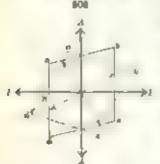
<sup>\*</sup> For danburite and angle = 20° 14 for green thankers, and 50° 14 for blue (Curic.

### Examination of Buszia, Crystate in Polarized Light

### 411 Sections in Parallel Polarized Light with Crossed Nicols,

Interference I was a little species of larged cross so when examined between crossed in a singularia with many experience color. The color will 1 just 1 just 1 just 1 just 1 in the few was factors, the to know if he word in the the know if he word in the the know if he word in the substitute of the higher than the region is a stangence of the substitute. The higher than the region is a stangence of the substitute of the su

I truct on threet was A so to now the norm so personal is concern which we during a contribute two rates to on the norm so personal for programs at 500 there are in which it species said. There are the positions of extra 100, or are those positions to an it with the orbit of property of the section are property for a right major that the detects has of extra 100 a section are promised or at right majors to a created by a first orbit of a section and a created agree of the section of the section of a created agree of the section of the section of the created agree of the section of the created agree of the section of the section of the created agree of the section of the created agree of the cr



call et in I have to have no para to be to these crystal er of in directs has the extraction is said to be unclined.

for example in Fig. 608, at the two larger rectangular are we represent the solution traces to be to the two areas and between which suppose a section of a beautiful reyst a about to be proved so that one edge of a known crystal depends of the solution of the white the proved to be sold to the device trace of the section of the device of the solution of the pass to a fine section the section that a distribution is not the pass to a fine section these distributions is not the section with the stress of the section of the secti

have to be turned to the position of head in order to achieve this councidence and so being about extinction. The angle indicated in the figure) which there has been accepted to the view to place to obtain the effect described, is the angle which has been accepted to the view to be interesting in the gives plate makes with the gives created grapher edge and it is taken to extinct on angle lipson a brazilia to remark the contract directions for ught of different colors have be sufficiently income to each acids accept that to permit implete extinction only when many absorpts of ghit is used.

412 Measurement of the Extinction Angle—It frequently becomes important to recreate as accurately as possive the extinction angle of a section. This is need commonly tone with a recrease peak the temperated with a revolving at go having a greatment circle for measuring angles of relation in order to measure at extra tion at give as of course necessary to be able to locate to the section same actuate cry. I straphy frects a Classic usually provided by some creatal intuition or manage crack. It is crystallography direction is brought parated or meanful the cross-basis of the interescope and the angular position of the interescope stage noted. Then the stage is rotated until the section shows its inaximum durkness. The angle between these two

positions is the angle of extinction desired. The difficulty in the measurement has in the accurate determinant in of the position of maximum extracts in I respice as it is possible to rotate the increaseope stage through as are of one to twice arrays with at any approximate and are affect in a id. If we hap at determining the point of maximum extracts in the plate in turned they and the point of extraction unto the first time in manufact in the maximum accurate back in the three direction until the same strength in the maximum accurate the point desired. The measurements should be report on a number of times and the overage taket. It is also advess to the report of a number of times and the overage taket. It is also advess to the report of a line of the existing of the position of the crystalogy plus case of the should be to be up to the position of the crystalogy plus case of the should be to be up to the position of the crystalogy plus case of the should be to be up to the position of the crystalogy plus case of the should be to be up to the position of the crystalogy plus case of the should be to be up to the position of the crystalogy plus case of the should be to be up to the position of the crystalogy plus case of the should be the position of the crystalogy plus case of the should be the position of the crystalogy plus case of the position of the crystalogy plus and the should be the position of the crystalogy plus case of the crystalogy plus case of the crystalogy plus case of the position of the crystalogy plus case of the crystalogy plus case of the crystalogy and the crystalogy plus case of the crystalogy plus case of the crystalogy and case of the crystalog

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The power of energy process to there to be you all crystab agree place gain to got of the fermion of pad engage and got come Ar 402 in pass there so a graph as at a transfer out they recent transfer to be a married to the age of the angle In the trape a correct input appropriate and into what there is a diagrams appeared out there refrom right and a participational le The fair two perfects in there and of and I be need not so also then to ... I may some buller the fight and of the property on their time of the property of the last of to represent purificilis install and on province of an exist of all all about the firm as proceed version or at 18th - party of the structure prestrong I we have a real than a general place of a few to of the 8639 to be an entered acres began a threat over from the all a set my deals a non-lag title. But a ser the principal table spiin locar in eight arges to a print of the printer of being direct or the man to some and If i be to product the first transfer to the first transfer to the second transfer transfer to the second transfer t with a population of the form of the con-

right to been sen as ill response to the response of the figure of the sense as the further less to prompt to the expensive appropriate to the response of the first to the first of the response of the sense of the response of the first to the first of the response of the first of the response of the first of the response of the first of the sense of the

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And by the power processors upon the same most place the Berty, but we are to the man coal house the property described by Wing and compacts of two situations of two situations of two situations.

<sup>&</sup>quot; see , see I peer , to a do see to a long to the second see and the second see and the second secon

from a left-handed and the other from a right-han lot creatal. Above these are placed two wedges of quarte, a right-hander, wedge attend the left handed plate etc. At the point where the wedge is earns in theckness to the plate peneath there will be zero in taking of the light and between proceed many this w. I produce a lark inchees the field. As the Latance increases from I a to be amount of rotation of the light increases equally held it appeared three to have a respect the central level gone of the plate. But anyear of the parte will be equally clummated if the concrete seer on as in the position of the tar one that if the latter is turned so that it me beer subtracts its take for gont effect to up from that of the quarte place the two houses become difference of computer. He maying the pure in or out a present can be four I where the charge a rear in it on as reast marked. This quarte is ite us need with a space is or if y presided with a such a such a piece in that he course trade may be a purposed into the appropriate at the fees plant of the own ar and with the red at the of the per parabel to the plane of vebest one of the polymer. A cap is or as uses above the ocul-r

413. Determination of the Birefringence with the Microscope. The trans is in the fringence of the house of the nax in an I in tragence of the absence of proper of the friends of the special and the set materials of proper or at stock and of the sacred trackness by hotoig for inter-

ferr tore over the prescribed to Art 363

414. Determination of the Relative Refractive Power. The rest verificative power of the two victors alreading in a the section is ready detert used with the increase per in parametric arrived by the the transfer comprises on the occupance of the occupance occupance of the occupance occ

A created worth is a solid to have point be designation if its breches if extenmost spin sample a controller with the set of a 2 fewer A the congression properties. The solid types on the usual magnification necessary to the remove

telme a power of the two breche to

416. Determination of the Indices of Refraction of a Biarial Mineral --The magnetic affection of a hazard in metal are determined by the sate of the large total previously see Art 333, is any appropriate for the fact that takes principles in december, a, p, then y, are to

be cheen sed

Means of the Angles of Releasion by Means of Person. Two or three prises and it has present to determine the three prises. If three prises are present they are cut so that their edges are present respectively to the X, I and I have been fitted adjusted. It the case is at relicit information and, to which these tree one are pure at the directions of the large treatment graphic ages the orisin seages would not to be respectively partial to the a, I and I create a so fitted directions of the time and the systems of the time frames are fitted directly formal to the systems to be respectively partial to the a, I and I will the reference and positively formal to the one we suffer that is, I return pure of to be edge of the prises to be done time if by the use of a rival is considered. In certain cases at three it here may be discussed from two prisess. If no prise is cost so but not only is our entires person to be of the free times \(\frac{1}{2}\) and \(\frac{1}{2}\) but so that its mesons place continues per only is direction the cheer that we fitte the first only in the fitte person of turning and deviation at and a number of their with the fitte time of the two

refracted rays. Or with a small and contemport so that one of its faces contains two of these circes, the the curresport ing two indices may be determined when the most of f perpendicular mode or is used upon the face. In making these mass abstracts it is it portains to note the case along it is directional pure sell to which the different rooms a brate. In this way the optical orienta-

tion to respect to the erestallographic direct has can be determined

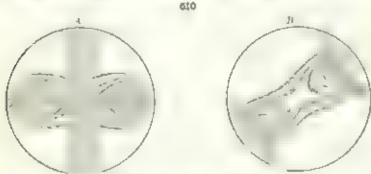
Mithal I Tank Referent the method of and natural in for deterin thing the indices of role of a hold a baseful inform, tage the class may advantage that it is a stort plates of the money if or required material of expert, by opeentated presses. In general they the surface that ate will give with the total refracts acter two be putanessed total reflection. But I have shad we make when the section problem | in resultings should be taken in received and to the incremental period period position of each beauties. The argest male and the figure to, whighte on access no the vices for the greatest and learn has a refresh to see that a three three feet of the second be derived from the filler of the effective superior the little are series to be of loss or any net part site a with these sec it offices also readings can be theter in order to free will be the cornect one for the move of the count months amples that do use for their pre-hanny and sept grandings of ein it has It will be formed by a gibb second part out to a recognition angine corners, le with containing between a the first place at a the were large shows to as a copyrage being. The arge that a coll is to that we plose is the compound. If the pate is given relations to paying re attacked by many to define to my 1 } and all three in the a he of this east from the wag in c. In this case one of the boundaries if tely princes a systematic for different poset is of the use to Das corresponds to the car as most a tipa was in morning to be surface of the parter The other to make with sorts its souther as I profession to the continuous to meet the national in teneme positions the angest corresponding to the other two or to become it replaced upts

416 By Immersion in Liquids of Known Refractive Index. The medicals er placed treating to those caparabed in Art 330. It dis use of avail papers to wear to apports to formed to regulate to what appear on directly the prior selections because If the open I transcripe at the regular graff a with the first artists of the at the later that there is not processing to select the representation to be great a file of the selection toterration on macross of closers to as all mail not case appearing to the sacram for entire forther of it is pure the tentents of era a typican we det 417 from the new bullgrain those going cuttions, good was a section If box it from the a bride is fraction permil to the tries of the extention and outlier a ne y . The index 3 w has given by any great which are perpenthe day to the axial plane whether the conference by to it or term of hot Such a great can be progressed by the fact that in the authorization payor a I'm , a tag the points of emergence of the often also whether that is with nor again a the field will in all cases tasse brough the center of the full to case be printed being studies like the rather good clear igns, the transfer grame will in go and be in the charage as new line or the the qui wroternat diete at the first at latter or the hand a good cleavage prace will of an la paralle to one of he place become of the pe I cal a ricture and therefore gave tchings a the a new of encool the in hees

desired.

417. Sections of Biaxial Crystals in Convergent Polarized Light — In general sections of biaxial crystals when examined in convergent polarized light show interference figures. The best and most symmetries bigures are to be observed when the section has been cut perpendicular to a loscotrix and preferredly to the neutral laterax. If on his section is examined in the convergence of the example of the convergence of the example of the example of the section of the place in and his the will optic consider to the direction of vibration of the posserver the figure is said in to that of Fig. 1810. 4. When these two directions are included at a 45 language to figure is like that shown to rig. 640 B.

I get a contact the interference figure at the parallel position. Fig. 610 A



Biaxial Interference Figures

form a cross comparing an increase of a unique of the best control bar is the first and be for depend than the vertical me. About we will be a between a concentrate since of any substituted at a control of the first and then a they all argo compare, forming fact a figure right and then a closure caree. As the section is cotated on the increaseopt or polarisation at the black bars forming the cross separate a top center and curve secress the role projecting on these points into all the formal day, E.g. 613 B, Inc., form the wearms of a hyperbola.

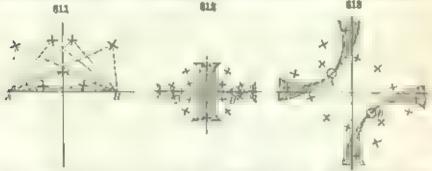
A base immeral has two directors, the directions of the ciptic mass, along which light travers with essentially no double refraction. At those points there would be no the fragence and consequently dark spots would resure the parks of the light rays become inclined to the directions of the ciptic axes too light suffers of these refraction and in our is not legare as the amount of melinet on becomes greater. Consequently a short as ances away from those points the light must be refracted into two rays which have a difference of phase of one wave-length for a certain colored light the yellow of the sociator frame in this case. The result will be extrograshment at such points. The assemblings of all points where the difference of phase occurs one wave-length yet. Is the first dark elliptical curve, coded a leministrate, shown in the figure. Further out will be found curves embracing the points where the difference of phase is two wave-lengths, three wave-lengths are

If the interference figure is viewed in daylight instead of the monochro-

matte light the black curves wal be replaced by colored ones. Each colored curve is produced by the chromation from the white light of some particular

wayr-neg 1 of light on account of the interference ex, ained above

The convergent bundle of light rave that pass through the section will each have its own particular plane of vibration. The directions of the planes of vibration for light contenting from the section at any given point can be approximately found, as expanded in Art 406, by bisecting the angles made by two little connecting this point with the two points of emergence of the optic axes. Fig 611 shows how the direction of vibration of the two rays emerging from given points can be obtained in this way. These directions of vibration vibration of virtual on virty over the field and consequently some of them must always be paralle or very nearly so to the planes of vibration of the need pushes. When this happens the light is extinguished and darkness results. This suplaces

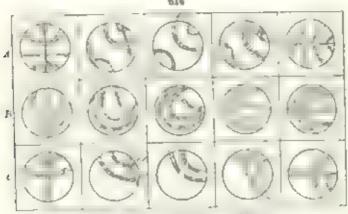


the formation of the black hard of the interference figure. Fig. 612 shows the large in the crossed position and Fig. 613 when set arrated into the hyperbon arms. As the section is furned the vibration in directions of new poil a successively become parallel to the planes of the meabs and so the dark bare sweep and curve norms the field.

With a thick section or one of a numeral of high birefringence, the number of so ored curves, when the figure is viewed in anylights is greater than with a thinner section or one with low birefringence. An instructive experiment can be passenby in ting the changes in the absertence figure instanced from a section of imageovite as the materials section factor and thinner shorts. In most rock sections the materials are ground so than that their abserter me figures do not show any concret nurves but rather only the dark hyperboar bars.

The haxial interference figure varies in appearance with the change in the angle between the optic axes. Where this angle is very sinst, the figure becomes practically the same as that of a unit of crystal. Where this range becomes present than 60° the points of the emergence of the optic axes will continuous to outside the interescope field. In the latter case the appearance of the optic axes will continue to appear as the section is brought into the parallel position form a cross, and then as the section is further revolved will curve out of the field again. The larger the axial angle the more rapidly will the bare disappear from the field.

A symmetrical interference figure may also be obtained from a section cut perpendicular to the obtase bisectrix. In general, the obtase axial angle is considerably larger than the soute angle and the interference figure will differ therefore in this respect from that obscured from the section out perpendicular it the neute is section. If, no wever, the axim angle approaches 90°, the distinction below it, the neute and obtase it deference figures is Thoust to make if the criter of the figure out, its closely with the center of the field, it is passed as a moment as to use the argie of rotation at which the aspect has leave the first as an indicate that to whether the section is normal to the number of the negle of rotation necessary to take the hyperbolus out of the field is greater than in the case of the object section. It is reasonably certain that, if this at ple 12, the angle between the position where the hyperbolus form a cross and the position where the field is greater than 30°, the section is normal to the acute bisectors of the acute bisectors of the angle is the than 50°, the section is normal to the acute bisectors of the angle is less than 10°, it is normal to



Exercise Burnel Interference I gure

the bruse biscering. For intermediate angles unless the two sects us of the same pattern are at adults for emisperious no positive ductor in car be ande-

It is all set at to be do to recognize the teacher detection by tree which are channel fre a name of section. They are this yet materized by the fact that the hyperholy bars curve as they cross the first in the case Is one the section is prime to a place of symmetry of the operal structure the large, cross the cut radiche be I mastemph line mere I to program other createst to it the service the see or dwarf theres characteristic costing isnes the figure from an ecceptive amound lighte in which the bars of the cross make its oranget there as the section is turned buy 614 shows in the row A a series , quite, but the appearance in lifterent twent our of the higher when the section is a girtly needed to the bisectrix, in row B a secure where the section is cut perpendic nor to un of the axis and the hyperbol. has revolves it the field as upon a proof. It this case the bur curves will its or new side toward the posts towarder. If the isin angle was 965 there would be no dist netion between acute and obtain languages and the bur would then revolve to a strught line. Therefore such a figure indicates by the amount of he care stare of the ter the arc of the ax as angle figures given by pranes out nearly norms, to an of the arts are often of great

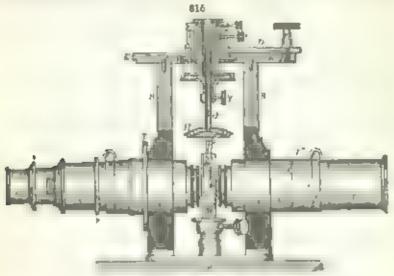
by in the optical examination of a nuneral. Sections which will furnish them age out y face by thing these sections of the mount of that remain costs or rays at faring for ret in between cooped tiens. If the striple car al with the style in the resistance of the control of the control to the freeton of the reaction of the reaction of the section of the see on and exposed must be contracted, whether here is, can be letter and by to a gether clarater of that ex not properly who I would be come I work the curve see Art 422). In it this observation the pass, a for target see character fitte in act, can be be emined. In made by tild, or she and to the state of th ert partyre to the stad plane dise not give a second orderence by re-Often it acoustic to its agrash at first the big are obtained from a securi end property to the open cases of a plante, the total new Art 400 in an atwrite a resease on the annual respect of the first and the first t full an over report page per a relieved at the fet are hapeth or prose Lat by ore and out I be head. In he part of power so has a say that als a the field Was turned from the poets to be brown as track and respicue a cope or up tracks. One past of arms we see, I appear too can also to be seen but a refunctioners. In their relative at a who again to present the time to get a deal was the get the en use I have not been and has we asked to be and the tree is dealer and the third better the fire and the series that they efficient all two filety research to reaching to content what at was ingo by water pier, wan whatever fr in the earlier to Express to the treet of the section of the treet of the section of a transcending the party for the second of the first and are from a sharpe of progression of the first man or a factor of he went to be highwest as a state a service of sector 400

to a pay the at the state of a read and a state of the real t what when a getter the enter the enter the property of the t Success who by the company of the are by the form to be granged of the and here to expense of the later and communities to be forcing of beings men and a be from the agett west, on here terrors by the section of the set of the section of the section of Proceedings of the second of t that hand for the poor to the sect of the night at 1 the sect of the for the second from a copy of the second second of the second sec Kenny and and special to have the state of son of the same to be an arrest. and there is at higher berein me to be personal the sea matth exact the sector a synthesis top per sens, mente a esta rete apper fine e and a the stage of the transfer and the transfer of W. OW

If the equal single is sign the excess the suffer total rath of the law rises were not see here to a set to perfect the perfect that the perfe

In the map only of excent two only the acute an accompanies to provide the

to measure—but sometimes, especially when oil for other liquid) is made use of, the obtuse angle can also be determined from a second section normal to the obtuse basetime.



Axial Angle Apparatus

If E = the apparent semi-scale axial angle in air (Fig. 610),

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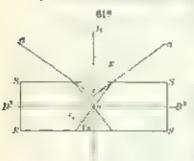
H, - ' semi-obtuse angle in oil,

. - the (real or at eric rusern - cute angle,

. . the (real or it er or) at it obtese shigh,

n = refractive nodex for the oil or other medana

B = the intermediate refractive order for the given crystallized sub-



next the various quarter es the proposition 
$$E = B \sin V_s - \sin E = n \sin H_s$$
,  $\sin V_s = \frac{n}{B} \sin H_s$ ,  $\sin V_s = \frac{n}{B} \sin H_s$ .

These formulas give the true interior angle (2V), is in the measured apparent angle in as: 2F) or in on 2H) when the refrictive index  $(\beta)$  is known

410 Axial fingle Measured with the Microscope. A per counte occasionement of his axial marks may be to take his various continuous with the tax research. In those cases some sort of a zero conserver scotter in such which can write no engraved scotte. By making of this scotte is an one of the continuous assumed.

tween the points of emergence of the eque asses can be octern ted. Malasse showed that the distance of any point from the center of the attricence figure as observed in

the mirrowape is very river. The source so the same of the unger which has my emerging at the most and the section is the part of the section and the se to the sale of the × × 1 A 216 a proper and a time and A 4.0 A TAGE 447 ment and from y a cre of community to the second 62 2 A BUTTO A 5 10 10 10 - 10 4.41 NAME OF STREET 4 5 NO F did the same of extion at 1 1 4 dogs 1 100 1 10 In 11 . let a reserve to the time was it the unit and of F 15 he 2 120 1 . The cover a binge e creal stage with executivy Fedurov, is a the state of the on top of it. It we 1 479-9-2 Ny Jane The state of the s

4 44.7 TERRES M. M L 4474 75 20 N E 34 er. . . 6 40 the state of SURE H 44 Inter 5.4 4.70 -11 . . . 45,00 45 Ty 464 20 H. 2.4 4 I read the method of friendscatter the feather is printed to the term or gaven become t

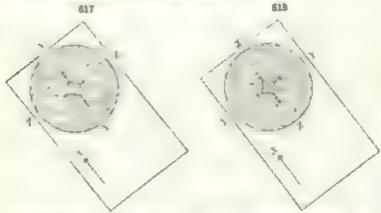
421 Determination of the Optical Character of a Binasal Mineral from Its Interference Figure. Use of the Quartz Wedge. If he was to de himself in the contrat retice figure in status 45 personals and that the present wedge reserved the sent of the optical figure is a processing above the sent of the sent of a gradient of passa to a processing account of the sent of the sent of the center of the figure will extend that the sent of the figure was gradient of the figure will be to the vibration direct, as after a particular wedge will be regarded to the sent passage of the figure will be received to the sent passage of the figure will be received to the sent passage of the figure will be referred to the sent of the figure and the same the sent of the sent of the figure and the same the sent of the sent of the figure and the sent of the se

Winchell, Elements of optical Mineralogy p. 200, 1928.

Am J = 24. We Johannen Varial J Schrigenium VI see a 12-re week, J = 22 u t 1

this process. The measurement of the optic axial angle of so needs a thin section. Am. J. Sc., 24, 217, 1 st

by the arrows shown in Fig. 617. On the other band if the quartz wedge is so possed that its optical orientation is opposed to that of the section, the effect will be the same as if the section was badded and then section. The colored range thour the points of the optic axes all expand and they meet in the center as a figure eight and their grow of cards as a continuous curve. The directions of their mevenions are shown by the arrows at Fig. 618. Therefore, by knowing the optical orientation of the quartz wedge and as ting the effect of its in respect to over a section upon the interference figure, it is possible to determine the relative character of the woll important exametion directions of the sections, that is, it determine whether the ray vibrating in



The series altern of Option Character of Backs, Monta, with Quartz Bodge

the pane which metales the opticates of step or shough than the one which y branes of the pane at right a sense to the large on

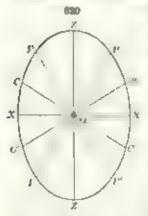
In the case of a positive is and to acute boartets, which in a symne total the epiget we age to at the area in thornal to the section is the done on I sensone by the direct of the me in the section which town the rightle facts ferrergons the fire sport arises be directed of the chiego type to min there is the duty to A. The direction I then wille in be place of the sec or all right as set the incoming the posits of our research the open axes, to be a see herefore of a positive is a rat, he has ar ray has a sail a ray by og it the operal axed plane With a pagative minera the direct of 1 st most the acute bispetrix and will be certain to be section, which the tree of will entire section more the the competing the points from the contribution of the drive over W h a negative namer, therefore the same of the arranch have withe optical name plane is of the slower ray. Its fit to got the relative character of how two, a grate in tired has the promotion for a mora is determile | The effects post to at I as the et more bigue which is perpendienal to at also a logar me will a water to present the property of the lite is emperature berefore but the pear its for two machines be upon tely known Will sections by an very tan or with merals of now birefranseparative interior per figure that show the her back hyperboles with it any co red rungs. In such cases irrequency he astroduction of the quartz wedge in such a position that its optical orientation is parallel to that of the section will suffice to so thicken the section in effect as to cause the appearance of colored rings. If inther, with such sections it is possible to estimate the directions in the section that are parallel and in right and is to the truce upon the section of the optical anal plane. Then he use of the sensitive that, when the convergent seas has been removed the character of the vibrations parallel to these two directions is easily decreated.

422. Determination of the Optical Character of a Biaxial Mineral from the Interference Figure Obtained from a Section Normal to an Optic

Axis. The optical character may also be determined from the interference figure obtained from a section nernal to an optic som. As stated in Art. 417, such a figure consists of a single har more or less curved, that rotates as on a pixel in the center of the fell when the section is torned. The curve of the har is always convex toward the acute biacetrix and cureave toward the obtained biacetrix. If the axis angle is 90° or nearly, the har becomes straigh. In such a case, he are erro nation of the positive or nearly echaracter of the naneral is impossible but fortunately such cases are care. In this interference figure, hig fills the trace of the axis plane, sects to curve of tac har and the optical freetom.



to the direction of the neutro hose trix (i.e. on the center of the field in the direction of the neutro hose trix (i.e. on the center's side of the center) would have one of the obtained purallel to a and the other in tool toward the direction of the obtained besenting. On the other side of the six in the



arrection of the obtase losestrix, ght would have one of its albeits in all parallel to I am to the other inclined toward the scott basering facts may be more clearly up lets ook by a consi legation of Fig. 620. It represents the principal ell, would see on of the makes ext of a book of present parallel to the option and plane section inder considera of is a rotal to an optic axis, as P. P. and is represented in the figure by the light ( which less in the aren're westing of the elapseon. The direction I is normal to the plane of the figure at its center to an the always ore of the transeters of any estational section of the the entry that is parent to the new plant to the to passing through they seem it as a corre of rave with varying irelevations. Therefore for light passing in directions that he between the ones

P-P and Z Z, the variable semi-shameter of the e-p-cal sections of the indecarry that are normal to those may we gradually decrease from the sength of O-C (which is equal to 1 to that of O-C that is, in all cases it will be less than 1. All such sections in refere will have the ray which equivalent, the axial plane particle more of the nature of the vibrations parallel to the obtase base trix. In the same way, the empheal sections is rural to the

rive the tg to diese in between the per P P and Y I will have their has a series reas grantly enginest in a technique the large worth on west on to the total we have the the week a record to example to the end of the end of the profession to the profession to the end of the end B will a reported the state of · भारता कार्य : जा राज्य एकर हता - मेहताल क्षेत्री का सिंह का एक बहुत The rise construe the territor to the either a . I be but the state of the state of a quietz wedge till the rest and fitnesses of the seal the per and the factor are the fit as a serious for the fitter taxores our will he and express Is night to another use rights to the and the first are specifically the explanation of the explanati water, they was a great property of second and a party of the week I am the state the state of the state of the many and the second of the second of the second of the etr. r for A w week m 6' Fraire en, Wha the street of the term of the threather and It is to be a different to the party to present the party of the present the party of the present the party of the party o the second second second second second a great of a series and repeated or ergs, a take and the first transfer of the state of the s the state of the s er the party were a the merculated later to the profession from the transfer of the same

423 Abscrption Phenometra of Buxini Crystals. Pieochrosim 10. top 1 to a see a fine to a portion of the figures. the first of the gold to say the right their teams of his Il the company that the pt to the rest there also may e there to de grown from the end to be give to real and the trips right to the trips that lighter then properly to a the lawrest to end to the first of the contract the second Ky the Energy of the er the paper to at any temperature or a pure la b tre - 1 ) of free a regime a to I a t give a rady is g Pa top of t / polar a today of of I who all the town in the late of the meter as the male 1 1 1 - 17 1 1 of toler with child e see to describ to be a set of the best of references ght street till e top 1 2 septiments, at a graterial I by Thepen the this good in more remarks material fraction of the first terminal and the first terminal and the second rect ( ) de c ) , e y / see signer le concer s h gradester refer to a ready of the the section and without a water at 1 state I was the a reasonable to a great at a street to property at a street to secret a factor of the property of the propert rather with respect of the rest the state of the fire to medition the Ort of sections on the appropriet of the plant in terms of the control of the total

the end is never as the end of th

regarging gold reference indication as property and a second restrict an enterty content of the angle of the

# Special Option of Characters of Or to Kont at install

424. Position of the Ether-axis In the case of the complement with the six of the case, at the product of the case that is the case of the case, at the product of the case of

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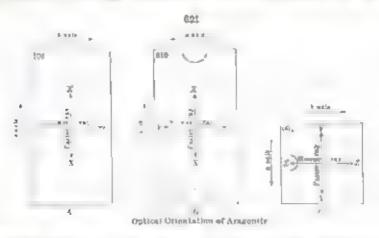
show parallel extinction

the property of all spectages that the parallel trans of the there exist the principal transport of the there exists a second to the property of the property of the principal transport of transport o

A PERIL CLASSIFICATION OF A LEGICAL

426 Determination of the Plane of the Optic Axes. - He plane of the proceedings that a the process is a right front on V rill ment be I THE COUNTY OF HE CAME AND A STATE OF THE S I on file on it was a state of the state of the state of the able to alter last the state of the above a tipe of the gold, but a hogelited to word, the join put of an angerousa graph indirect of the contract of the first of the firs to real with any of part of the other particular to a service to to a gle stated and to a tap tap to be a part to prom to part to pre-A .. le Hase proposed to 1 g +21 1 B will If the e I report his notes I hear said of action open territorials are be to a transfer of room to the court of sea for a conand the will be the expension of many the greater year of the get entered engineers with the per of the and the self-better and the self-better and Il and the 12 to the the tax of a later that (x) the start I see that I from the the special to the to see in the contract the fix from the constituting the proposed to save a crite to some as to good, one of I have the the care to petter these The make are place benefit since a man to be found / and parallel to 100. If the sections parallel to (0) and out are crain too in

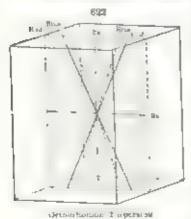
convergent both will show based interference figures with the points of emergence of the optic axes lying as a userwist in B and C. Fag. 621. The axial angle inserved with it exception partial to 001) is much smaller than that of the model from 0.00. Consequently the acute disectrix is a braid to acc



lege All or then out is the deer on \ the materials of heally negative its facts of our all order at a may be summarized in the statem has.

optic lly - Ax pl a 100 Bs, , 001

426 Dispersion of the Optic Axes in Orthorhombic Crystals. In dieter a right a class of a feather of a crystalla a means of temperature following the activation in a side of right legal to the reference of the distribution of the state of

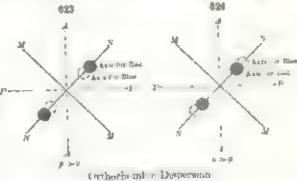


when of the I spersed constants up it but in cerea past, so pe a becor to coust erthe Oh on It size the age of our ction varies it this way with the caffer of wave lengths of agt the address of referetion will also the the plant of order as as narriedly stated to or to the targette of the profile commutes the part to referen of the three a bees t refrection, and my ! As these is commanders to the contract of differences learning upon the waye-length of sentereday the wather the opti-Mr. and A division with it of a life of the light soul (in tell) were a fine of the were the a dispersed big 622 represents with a case if all he has arrest appropriate an of a xea a res light a greater but that for bles. I prosts condition may hold,

it what the argue for blue is greater than for row. I'm a this it if have to the the refer on a great what is several a three light will be exactly contacts with the produced by red high the base roses of tech figures.

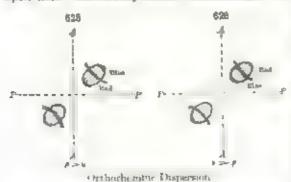
will be the same but the position of the points where the opt c axes emerge will be different and consequently the positions of the hyperbolas and leinmecate curves will also be different. In the case of orthorhombic crystals the espersion will always be symmetrical to the two symmetry planes of the inbearing that pass through the scute bisectrix, i.e., the directions M. M. and

N-N in Figs. 623 and This particular 624.type of dispersion is and to be orthe roombic arspereron, in order to "istinguish it from that a perved in biaxia, (T) % tale of other systems. The two possible cases of arthorhombic dispetsion are shown in Fixe. 623 and 624. In expressing these two cases the Greek letters o (for ted and a for violet)



are used. When the axes for rea light are more dispersed than those for brief that free as expressed as  $\rho > 1$  or in the reverse case it is  $\rho < \nu$ .

In the ampority of cases the effect produced upon the interference figure at the dispersion of the optic axes is too saight to be noted. In exceptional cases where the amount of dispersion a large the effects are clearly seen hyperbe a Lars which are ordinarily black throughout, will when the figure is a served it white light be seen, near the center to be sordered in one side The first one or two of the by a rest frange and on the other by a tilue one colored lemmacates will also be broadened our along the line priming the two opic axes. As already stated these changes in the appearance of the figure



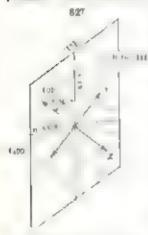
will always be symmetrical ir respect to the traces of the two symmetry planes ly ug at right angles to cach other. In the case, Fig. 623, where the axes for red light are farther apart than those for blue (a > 1), the hyperbolas in the interference figure for the two different wavelengths of light will not coat it and the ones were the problem is ox aign as red will be further out than

those for hope light. When red light is truck, it of the wire high blue ferrains, and her versely with blue a snotra ted the resident color is red Consequently in this case the hyperbola sate and he hornered on their concase sales by the and an their contax at I size red, Fig. 625. In the other c se, where p < v, the hyperbons will be nordered on their concave soles by test and on their convex sides by blue, Fig. 626. In other words, if note

tight shows at the larger angle of means that red light has been eliminated from ness positions and the optionaxes for red are more dispersed than those for blue, etc.

## Spec al Optical Characters of Monochine Urgatals

427 Optical Orientation of Monoclinic Crystals. In monoclinic crystals, the monoclinic crystals of section axis and structry, to be contributed of coxis, and the plane of sectional crystal graphs axis, and the plane of sectional crystal graphs axis, which is the transport of the flore of the flore of the flore of the crystals axis, which is a critical to the section of the flore of the flore of the flore of the crystals.



(1) contact to with the axis became age is appare or a the transmitted case the tipe as I and / a la me the the or at a sympetry page a nels supplies becomes the nationaxis plane. If A or has in Z courses are to be because for opterior to be will be a right region to tell the contraction in a partition to secret or the partition of the plant of the partition of th It is chiral printed as of a district the error of participation. after the beginning a sound sent out days, then or enter in Fig. 627 is months with a sign of cheved from a order a cryst . I supplied the Triangest of the filter special and service of give the cryst a graphy creen that have been of the second at a district to the second as district a effection light and a series a series per maying the process art is referred the or by set I from the first to get a law nor , trothe siete, West the second to be and at the term of the skip is seen to be a seen as high fact fabe in the said to be a few and the bigs

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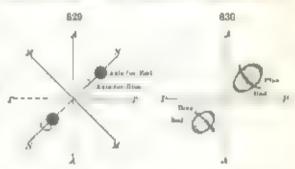
deriction of the correctall great and the agreet hand to be used as red the old the section of his extreme copy as in her coming determined by the section of the metallicities of A est be being and It a disconsisted by the a top or retrievalation the material way to a separate or in critical little or at 18 years the converget that a somewhat a sport in there is the a some as Want too mently is the filter of the state of the second of the sec type for any territy and of the tall to not a tone and a discovery they is appear man alcolor for he set a girle to a portional Its specified the figure operated to all to by with a segue dealers premi a te por el a de le per 11. Vet 6 the the er of their friends of the centrality for the starting from the transfer of pose the character from more than the ends the character a tree of of cresting he aging the two other paper a classic would still got a con-Charles and a tirel not all as

428. Extinction in Monochine Crystals. Silve its one of the three principal optics of each as, 1 1, 17, 48 monochine crystal concertes with

erystallographic exist themels the expinientry axis but follows that only seed as the are part of the axis are sections in the cethodoxic zone, who saw parallel exemption. All aborts of these will exhibit up ned extraction.

Plan

429 Dispersion in Monoclinic Crystals. As previous as feel there are other pressure of articles are for crystal. In the first case that it is first difference by a case that it is first difference by a case described with the first case of the symmetry are supported by the symmetry pressure that the symmetry pressure



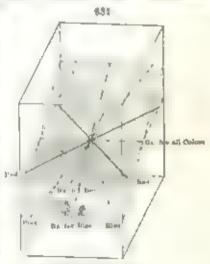
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contendes with the crystallege place axis band the optic axial place is at right pages to the crystallege place symmetry plane. Under these can be that

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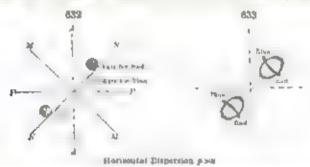
I see to In and Dispersion - Inthe approar as becaused, the case
where the arction becomes we are
axes to This as an interest in Fig. 628.
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axes to report the approary the axil
axes to report the assumes of these angles
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to the plant and the less trees
the argument than that for the I had
the grant of the dopers in of the bases
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of emergence of the optic axes for red light has beyond that for thise, who each the other sade the conditions are reversed. Also the optic axes for red

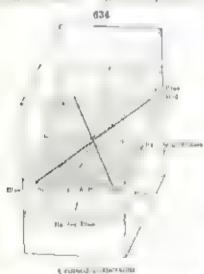
and blue will be further uport on one side of the interference figure than on the other size. With this sort of dispers on the interference figure will be symmetrical only in respect to the size which is the trian upon the section



of the option cool in tech to the fig. 620 but or more referral to the line as

right angles to it, M. M.

Instead a pair of soft and the interference figure by the fact of the court, horders to the partial of the fixthere in the work construct for the partial of the fixthere is been a formal of the fixthere in the construct of the fixthere is a fixthere in the fixthere in the fixthere is a fixthere in the fixthere in the fixthere is a fixthere in the fixthere in the fixthere is a fixthere in the fixthere in the fixthere is a fixthere in the fixthere in the fixthere in the fixthere is a

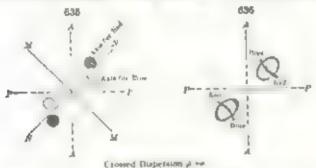


Casa 2. Horizontal Diepersion. -In the case to cr. Hoggaph, was b coincides with the obtain bescatrix which may be either the X or Zahree-Hot dipendance of the the even (a to place its passence of a stratus in character. In this case the direction of the other less tree is to life hight. of all wave-lengths. The angle has tiver or the open and a second faser the percent files to paytrix may vary no long as It lies in the pristings but sametry pare la over a gette the and phase may be dispersion upon the death of the people to or chargeper of a contactor of a plen o > v, for blue and risd light, might therefor be to that shown if the 632. It will be noted that in this case the reference figure to a ed of er for fe from an out of the state s purpose for to the cole besself a sig-

For the late of the late of the second of th

concles will be could over my which may be enter the A or Z direction

the pricing port the optical character of the crystal. In this case the direction for outer has trives for high of all waveslengths. The outer between a outer accounty vary and firther the position of the axial planes for it ferent a resignificant vary as long is they remain perpendicular to the crystal part of one general fitting and the solution is shown. Fig. 6ad. The critical of one general fitting and the sale of the solution is shown in the case the figure is symmetrical to the trip has all Market V value of the critical



point of a figure oc, the most of emergence of the ments become Fig.

# Special Optical Characters of Tructure Cristals

430. Option Orientation of Trichate Crystals. Placement of the option of the center of the second ryanger of t

431 Extraction in Triclinic Crystals. Some there is a part of rate

the personal of a line time to

432. Dispersion in Training Crystals Recruse of the lack of companies as an invested at the adopt plant december in the contract of lact that a surpost only area in Consequently to depend a stantill a secretary contract of lact that a surpost only area in the adopt of the adopt

433 Suggestions as to Methods and Order of Optical Tests upon an Unknown Mineral. Preparate of Material. The size of a restaure of the region of the size of a restaure of the region of the size of t

glass. In the majority of cases of will prove more expeditious and conventest to place the fearments in an oil.

(rede first on free Brow s given a brief on ane of the natura, order

of a begreat one and tests to be made upon the manerus

Charmate no a place polarized light without the upper nicol

Chatering dusters who her inform or hot

b By a top shife of increasing stonge to the posses de identificant it in the wholes pleast roism a coldent be recticate (cr. to be tor to pessible to treet us of absorpt on with crystal lauraptue directions.

Y to erve a outtine of any clearage erocks ofe d No e inv nels its there inpe ar i arrangement.

- e li lex of refere on. Describble a proximately the refere we index Note that, we of the and determine whe for more a and a hards to see index that the meaning in which it is immersed (see Art. 880)
- 2. Charm some in physic polarized light with crossed nicols
  - c. It has seen a mandark between chasen faces and purposes so during the first to the stage the mireral is a ner estropic or are entries perpetage dar to in opto axis. In the latter case test as indicated below under 30.

b. If the second is a constrainty ght and dark ouring the rotate mof the

stage the mineral is anisotropic.

A to position i extract or directions. If they are nebred to some at we ervelou graphic direction measure the angle of meaning-LOB

d. The corner the relative character of the two vibration directions of the sect to ce the two extincts to direct us, as to which enrests , at the faster and which to the sometime. Test to be n no with quarty nedge or sensuing that see Art 384

e Fig. is grad showing the nights under if there represents and is approximately refermant the strength of the materials ince-

(magence.

- f By a morse of a colle of known petraste s in long determine as neutrate vias weighte the range of he re to tive is a re-shown by the paperal. It may be pess or to trapert, p. w. h. tests wach under 3 a determine the vones for cretain of the procipal refractive indices
- 3. Observato his a convergent potarized light with reason arrows

a Nove wasther the materal shows an interference figure and if so

Whether is as as as in the con-

b If mutered as an extal league a, the position the of a axis at reason of paths the gives so the old those ble determine

the people of algebras between the interest

c. If we in negal as took of determine the post of of the axis, plane in respect to the sect of Texternate of possible the positive of head of characters the historia. Obtain possible an approxin At ha as to the size of the excal angle. A de any expenses of Justicipanian

Yote - in making the above tests it is beloful to keep, as far as possible. a grattur record of the results, some long like that illustrated in Fig. 621

434. Effect of Heat upon Optical Characters. - I be general effects of and upon crystals as regards expansion etc. are spoken of later. It is conon I however, to constar here briefly, the changes produced by this per somethe special options characters. It is assumed that no altera on of e came a composition takes pince and no a morroal change in molecular s mer p. In general, the effect of a temper , use change causes a change in a refrictive nations. In the majority of cases the indices decrease in at a with rise of temperature but in certain cases the reverse is true. It a neequently important in any exact st centent of a refractive index to g. to the personne at which it was de entitled. The paracular facts for to patering option, classes are as follows

I I do p. ecostals remain act report at all temperatures. I rystals, how-+ or which has sortion chorate (Natat), of Case 5 p 88 show or mar we can be may have their peacory power actives, in this adictance it is m-

en sed by rise of temperature

2 mining crystas similarly remain around with rise or full of temperamy the may arrisg noted a capaca on in the regard explicit of which that a with samplest, of the deal contraction. This increases it recently a write e to and grows weaker with beryl and quartz. It is, further, interesting to and their areas power of charts acresses we rise of temperature, but to releast for all parts of the spectrum reals has seen buy the same

A l. Br. 1 H we talk, he affect of change of temperature vames with

the system to which they become,

I warm and a second common that we man are at no required temperature for the we have the west and wrong here to analy a record a fearth of the and a see the song to in the and to the son has been the as a comto at my our tell and are in the parcent, it means through these g are we was a second to the refractive indices at different temperatures.

to the case of orthorhombic crystals, the position of the three rectang larther axes carnel after since they must make coincide with the crystal o-The view of the enter it in the lowever, may change and I not so to here also the optic word ingle on real orchange of axial plans of

to provide character as thus possible

With sometimes crystals, on other axis must conscide at all temperatures. as to the expect symmetry but the position of the other two in the plant of ere person a secretary the west the possess change in the value of the rely cit. These may cause a varieties in he digree for kind of dispersion na well as in the axed angle.

Will be last crystals, with the positions of the other-axes and the values of the refrictive indices may contact. The observed optical characters may

therefore vary widely

I striking example of the change of outent characters with change of temperature a formers by we so on in one good? Then content this requires a otherwood by the former contribution of the formers is seen to the property of t a green name with of get a conjugation of the 90 . Ale we thin to interesting the which purpos are does perpendicular to hard the dispersion becomes horizontal.

An age interesting case is that of gla bents. Its obtain characters the normal con-plant is both in not be now by the The artificial or as in a great an about a O of a structure or or or any part is wavedrageth manables, but see a far new The the terrespect of the arm conflicts various from the first of got up the freed delete on for the grille of the right transferre, be interference by area

They have they are no to go to go they when heated up to a certain point, suffer a than gr at 'ar' are at a ' a area, and I'be her becomes greater at a to long coptinged

fact a net returning to the to right at position and remain a tered.

In a left in to the vire cases referred to, it is to be noted that when eleva-. h of the part are a secret with hange of chemical composition wile manger to be an electric are possible. This is this trated by the zeolites in the tes species, where the effect of less of water has been particularly

hart see, with some creatile, heat serves to bring about a change of molecthat strip to be stell outh that a to all change of option) charge its. For examto the greensless on reducal orthorh make greatels of antanony undage "b4, 65 he d for to abs. 1.1" change to red unaxid hexag and crystals. Note has the remarks in de later in regard to the effect of heat upon lengte. and poracite (Art. 441)

435. Some Poculianties in Axial Interference figures.\* In the case of on axial crosstale, the characteristic interference up to a scale but leth from one course to take our roots to the account of the course but the course of the scale of the scale of the course of th

by contract to the

The same s = -1 so  $s^2 + h$  is to how trivial above a normal t = 0. When he we exer s = -1 so s = -1 so t = 0 the same t = 0 then t =so were as a ballow of more an error angett at all adaptated months to a set before water of perbose is

the government of the secretary between the control to the beautiful to the secretary of th

The time striking with of you that are a log size any afformation of a considered Art 437)

436. Relation of Optical Properties to Chemical Composition. The effect of sameng families complete a quantitie apon a common epictus agenman red specied with a second one sames of non-right is at a next with more at reals be a solid part of the game that the rest that he got to as the fire and moke to written to the me auto and chapter to special in a large or one part of which has been discussed in Art 327 1 - a average for the refrontese milex cars of et be approxmustch calm at all from the character composition.

Assume as crude the and are of the reason of the relation between compression and op to any more than the term of the decision o

<sup>&</sup>quot; har at a reason is a figurest market of more the heal of opt as an anadro are a state of latter Art. 641

he companies are of any internal are mainlest of this team relies group can be predicted from the position of the thereaxes or no reservation, the visita ion carections in the fem-

tangental cleavage-directions, r(001) and histor.

after if aryong courts during and rile bed an alebra of all the case of the risk paperson above or exceeding the first case of the risk paperson of the risk My bear , and not a course to year a to Washing a cases peeus he will end It as a sixty but he arrange a is a is then A tagety proving the a is a the a range a is a is a in a i resenter the container, the spice with partie and it plants and a hora, amorphis e tions have seen many out-

437 Optical Properties of Twin Crystals. The examination of secns of twin cryst is of any other than the to their essential and arosed babt serves to establish the got two had her over if the and has I sale withe tria we oriental us of the several parts. This is now distinct in the case of o start-twide, but is 180 west shown with personnel on twins, the high fiere the or a to be ally not experted by a district of

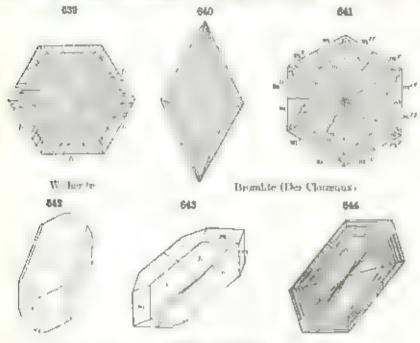
I us the examination of a section parallel to both of a tack gives as of game to of the type of hig 637, makes theirs perfectly to estimist the fact of he twinning but he to by the real at not one of the above to the to are The more my of can do so to sees to make be about the ex dieis rections in the two alves his end of a weet out of the ablisome charte crysta, ogra, be one, as the vertical axis

688 637 Ĭο 109

be povereithetic twinning of certain aperies to the tricial e fel Ispara, appears with a to fell in cross a properties has a properties on the course of the color of an a part cell to the band cleavage, the allers of lands ox eggs at ogether a new one to same ou where the specific sections in service the following in the section of the specific section of the section of t the I g to be the the another than the manage the han electron get and a real or one of er remember a present of the process represents the secretarial of the remaining and the secretarial of the now to you twine of right and here a not create to a just we the lesseny outs of that then a and have the rehard term to be president in the original gra-

So again, the true about or of a course on that war a shallong percebber interry in their error and form, can once by the condensation date with a liberty percentage by the der a resea section of an apparent bee agone or as the of without the new ground and any mental of broughts file 1840 has a standard complex structure as shown . . . . g.

64) Ing 642 shows a simple or stal of stillate. Fig. (4) is the common type of twin creatal or 1 big. sellillar tention the constraint of 1 big in representation promises, give the constraint in group of the 441 of which be uniterioral that the trial a reference is set if we create a write the parts are superposed of the chow many pressure as a 11 only sparage of court is 12 big who serve as an displacement.



Stabile (Lassula

438. A particularly it crossing case related to the lipect cose associan the proceeding article is to not the special properties a susceptional cleavages or also force is to not the special entries of the relation of the xilpetion of the passed through the center a flers or report polarized to a vertical which has passed through the center a flers or report polarized to a vertical to the first processing to the xilpetion of xilpetion

If he see, is it i true at lever to a bound on if to planomens of hours is a set. These for a now much light aport the a state moint as an warnet reson, created non-round as a wing on the polarization. Further it is easy from this of an error and now it is possible to have in sect. In a cream created so go if the core perturbs which are bound and others that are now at the latter being direct, in intimace twinning after this mothod of biaxial portions.

439 Optical Properties of Crysta The Aggregates. The special optical phenomena of the affect to be of or take a special to the special to who have pt as histories a can be at some and depend upon the cantide use in the therefore optical the maximum and their reactive intentions. The case of ordinary granu-

or feature or observer aggregates week to special discussion. Where however, the to feller ig get a age as he at which the famine except that it serve to do fixere

product of the participant of the second

the dotal fermet a latifaction on the company of the properties of to the state of the second of The state of the second state of the second state of the second s I to ourse or me as a to be by hope a give to a control they we the for one of prior a rile removed from the section itself, as on the river is have for a section of the distriction of the di

440 Change of Cpt ca Character Induced by Pressure - to the Gerence between The second of th

the war to a superior to the secondary of the secondary to the secondary t the later of the second of the and the second of the second o to a figure of a suff of the table of the tion to less respect tion to the property of t As the state of th A to all the contract of the c process of the second of the s II. \*

441 Optical Anomalies Since he early manager me of Browster. He old, in their 1815 of second section of the many or state for the total the way of the property of the appointed with my their receipts forth. I that Is a limit by the aparts as The state of a people of the other and and the state of the properties a pate to be and some a lot by the wards are a continuous A a real property party party at a state property and appropriately a selected representation and the selection of the select I B the print a potential and with the gard to the will be printed the man take the and treamphiliant to to cristally broxes for any to the clarations. the particular territorial of the state of the re was the property of the part of the property of forty-eight triangular gyramids, etc.

Sucressian in a can enter good or heageth species is Ves V to Ziterte, forty specific gold a share of gold distingthe lighter per large those it is not a see her charge to condition I as between remaind opts discountries as and sort in the planet that the appropriate ray, typic and te of a second And cases such as those pertrained are endraced under the commen term of

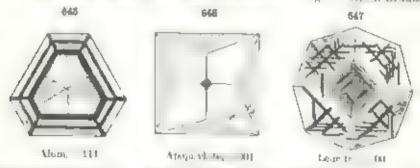
optical anomalies

This subject has been manually studied by many investigators in recent years and map right of in a may been made to their cases and the heave can sale. The result is not though deshifting cases and remain, many to the typical ones last formal, so induced by expanionals. No single

torsery least ter a pole and torsely app. 1

The right of extra, it volved has been whether the at mades are to be complete of the second ry and a monographic or shiften being to the interest a de contentat en el crestals u question. On the one banthe seen arged that in emiliary on suffree he 440 treat not during to an isome president or or or or or a person erve to the appeal or of amount a track cres of On the other had taken as clear I have made for prostores produces in a resolutional form and at the some car conor ils of cartiges 1. They call to one liptural step to see is "and at regardle will assist more compact, see as authorite but that In one bigs 64 to 641, prompere logs 12t, 478 490, which had as some des the of spot or a free thought of sent study shows the monoclarity turn servette in a dille hensen, gir an analogo of these he mades. Variable siles, (870 to 1) " wors the trace mondes conduct thesi case is explained in the assurption of a some or har sell more from to go not a die more as the of the best of the best of the property the is a verigin. I symmets than it it which must complex without crystals actually simulate

It regard to the two ments of view ment and a seems promite that interest tension the transfer of the sent and the transfer of the sent appropriate to the sent appropriate to the sent appropriate to the sent appropriate to the sent at the tension of the sent appropriate to the sent at the tension of the sent appropriate to the sent at the tension of the sent appropriate to the sent appro



dows the appearance in polarized light of essential or III, from a crysta in which the successive agrees have afferent conjugation. Further according to Brands the option peculiaries, for any offer spices movies referred to this saddle takes. He made a temperature to this saddle takes. He made a temperature to the base cases can at his one gurnets.

<sup>\*</sup> I read a prove up part is tradered of highly complex type are unfeet institute crystian.

n which the optical characters seem to depend upon the external form as acceptable to the re-beings also upoply did a seem of which from Gort to, a oracle of Re-m is shown in Fig. 646. The seet on has their notice will be ready the center of the crystal and is represented as it at pears in part of

( Inrized light

An there exists not but most priportian class is that including species of the bord of any beauty which are a morphism that so and species at the transfer of the properties of the secretary of the transfer of the transfer

Let us an all who we seem decide its the reference of the section of the section

Still again in a limited in inher of cases, it can be stown that the intergrowth of emelor having algority different cross allographic orients on a the cases of the optical peculiarities. Probably is a conspicarity example of this class.

After all the various possible explanations have been up had there still replace however many species about which is certain conclus, a cap be relief. In many of these species has the reset of Mid-antimus provide be at make. Indeed, it must be added that must inflanate of quiton will exist as to the cause of the optical unomalies," in a considerable number of manuals.

#### LITERATURE

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Potz vo. 94, 4 1955.

Pfaff Vermonte her ten hardings des Oracka auf its opinichen hagemachalten der hervataus. Pogg Ann. 107, 3 of 1959, 198, 1999, 1999.

<sup>\*</sup> A complete lablingraphy is given in the memoir by Brunna 1891 ner above

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Had Set Min. 21, 186, 1868

# IV. CHARACTERS DEPENDING UPON HEAT

442. The more important of the special properties of a national species with respect to Lene to hear the fellowing less in a refite a variet exputes to eague that in their relation to creation with attention of all early a fareers with charge of temporal are specific or and allers one cort on power of recognitions best rate to the first here were of those and concretated a lightly lies of safe of the range of the court tree wash. A few bytes because the empore their and became the effect a mass be made in tex slocks on Physics and to spect in three is some of which are turbs and at the tteration p 351

443 Fusibility the opposition of fishing of officeral mineras is a it portant character in the trap derig afferent species from a a an over by month of the short pro- For the purpose a second or each carefully awat for comparison, as cert when a the ar road or decoted a ti bonpape. Accurate determined his of the fast, my are office it and though if Lette importance for the above object to a ure numering from a theoryment standpoint. They have teer it or give by various nutbers by the case of a muster of different methods. The labowing are the approximate meltingeart calles for the numerous used in you hold some Act 804) Still Ac-

by take, 1380' mae for quartz, about 1600

444 Conductivity. The considering power of different crystallized rachs was early pressing teally Senamed. He covered the time of the side at local massing and with war at local crystall the time of the figure atted by a hit wire placed in contact with the order of a significial power later power by January as an local side by Rentger with a size of a contact of Sanstrane in la January as an local side in the first land the three cases and of purpose and of purpose and order with the contact with first land the three cases well as p. 256. In other winds, the contact with first land the three cases we can provide a side of the propagation of the land to the first land the three cases we same general axis to be propagation of the land to the second to be a some general axis at the propagation of the propagation of the land to the virtual axis.

446 Expansion. Expansion, that is, increase an various two rise of temperature is a nearly discretisal property for a so the laterature to of various temperature to property for a laterature to the confident form more than print a character to be present to the relative expansion in lifterest corrections is for a temperature to expansion in lifterest corrections is for a temperature to expansion in lifterest corrections in for a temperature to expansion of the confidence of t

in the preceding article.

The name of expension varies which, and as show its lambour the influenced particularly by the operage. Mustake the first that is a steril a send of the materials appropriating that discusses the form the appropriating that discusses the first are recovered as the

It is to be noted that a general the explanation by he to be into a secret or as pass of my has been distributed by the constitution of the consti

446. Specific Heat. The specific host of my substance with an order of own receivery to respect to the present of the great of the second degree that grade the unit of specific heat with a transfer to the second transfer that grade the grade that of the state part is a specific of a of the state part is a second transfer by fact, by the berg and others. Some of the response reaches are as follows:

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Case at sed expet 0 (780). Epidate	0.1877		Aragonda 0-2031	0.2036	

447 Diathermancy - Best les the slow molecular propagation of heat in a body invisured a 13 therris, conductivity there is also to be considered the rate t propagation of what is called righting hear through it by the way enotion I there are which surroughts us molecules. This is merely a part of the general surgest of light-propagation area is they discussed since lest was es in the restricted sense of fler from light waves only in their residive to greater leagth. The togges following on exerted by the body a measured by as district, may, which corresponds to transparence in light. In this sense or to say to the tagente are highly discovered by some have about but he of the bint waves passing through them, on the other hand gypsum and still there alian are emparatively other manners since while transparent to the short ight waves they absorb the long heat-waves, transforming the energy discrete of sensible heat. Measurements of the Lathermoney were early ainde by Medita, later by Tyniall Langley and others.

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#### Heur

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# A CHARACTERS DEPENDING UPON ELECTRICITY AND MAGNETISM

### I. ELECTRICITY

448 Electrical Conductivity The subject of the remove conducting ewer of there a universe by decime bone " In good to so use the ten of the time of the state of the stat excepter on they the help charter a stan force strill place - 1 the late tal rectiff a rich opening lapersa page to the total a first a feet front of the to the and the Heretand of and to a make the and the state of the state of the great of the state of t The state of the s The state of the s gray well are and they are directly

449 Frictions, Electricity | 15, 40.00 appoints of an electrical experience of the book to be a few for the service that the twenty of the to a le a to legree is a to a est is a three is a the state of the s To indicate or the factors of the least of the The fates of a site species talks the sale a city address. a distribute the stage of the same that the same that and length experience species is another parameters it is harton turber or rilea and a therapolice for its series is seened one, and an dress the terest harry statement after give rise to the word 1 1 1 1

450 Pyroelectricity The saturationals description of post stated I so burger of chatteries on their person he so the when in get the get that remights tally be eath as the east it was now a west a charge in his portion I may warrising a beginning with a leve spel of on spine bond liming may agree these ments only specithe rice operated the pyroceres the property on a was fire, a survey the case of fourmaine which is the abolished on a country are althe party of personality marked a forest to be a g to groupe of seeds he assign transcription of its hear of its hear of the assisted of carse, order with property files. The entires when the titues goest to Ress and Rose 1813), aster cy Harixe, a so ty groupe, hunds. the street was continued

In all eases the true that brooking if the error allographic symmetry sponse region of the state with mile with a president of the same to proper come and care is major a corporate. At most la lambo press of compile a green't bring of the first reservice profits

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I comprise that becomes, here parties politically are present charges of the organit extremities of the vertical axis corresponding to de lamine reprocessed training to this and rectler son or cases a carrier a which

<sup>\*</sup> On the conductivity of minerals, see Benjerinck, Jr. Mar. be. Bd. 41, 400, 1898

secomes positive on beating has been called the analogous pole, and that which becomes regar to this term called the analogous pole.

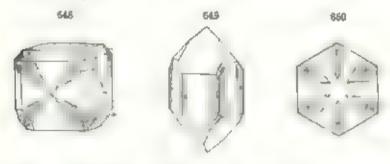
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Quint that is the temperateural policy shows a electricity on heating in a three deer steps in the class and a electricity at the three remaining who the case is a confirmable model of state a appeare to that of reflect and Twins may exhat a high degree of complexity. Of Pigs. 640, 650.

pore locss and Rive of the solid angle rr H', the antiogram pole at the

angle mr'N' neur plane a.



A very convenient and complements at for more quating the phenomena is the following with a special control of the control provided of section carefully and work of the following the character of an algorithm and the following tensor of the section of the following tensor of the following tens

461 Piezoelectricity. In language recording of a crystal to or lice pyroclorum offices and some change it its action to before if a change it yellowed a tronget line. It is a continuous such as an appose for each by some license of a crystal and as an appose for a day pressure of a crystal change on a crystal as not given to a day pressure of a crystal change on a crystal as not given to be true of the property of the two different open to a such as a continuous pressure of the property of the property of the such as a post to a a between the for real expectation of the property of the such as a post to a a between the for real expectation of the property of the such as a post to a a between the for real expectation of a latter property.

the atject has been received to by Hickel Cre, and these and erassess, theorem as to hard been not even in Hinke his also and even in the eras action of the property of professing at electrical condition by the influence of direct fact than the orite is a construct some even in the transfer of professing at electrical condition by the influence of direct fact than the orite is a construct some even of the transfer of the content of the condition of the conditio

462 Thermoelectricity I'm costs that the marks matids in general results in according one of them positively and the distribution of the distribution of the state of the stat

further, the point of cuntuet be hested while the other pasts, connected with ware, are kept each a certinuous current of each new years above, for example, to a suitable galvanometer its set up at the expense of the heat-energy minplied If, on the other hand, the point of numetion is courd a current is set up as the reverse direction. This pieus remon is cauch the modestracty, and two metas so connected constitute a thermoelectric craple. I rther it : found that different conductors can be arranged an order in a table - a seconded thermographic series - according to the director of the current set up on heating and age; rd ng to the electromotics poses of this current. Annual the metals beamuth + and antor my - a stand at the opposite ends of he sines, the current passes through the connecting wire from antimony to bear wh

This subject is so far important for mineralogy, as it was shown by Bunson the the natural metalic supplies stant farther off july ser a than bismuth at I mitim my, and consequently by them a higher electron of we force to reduced. The thermoelectrical relations of a large gamber of materials were

determined by Flight.

It was early observed that some numerals have varieties which are butl, + Rose attempted to establish a relation between the positive and orgative pyritohedral forms of pyrite and orbali to, and the pass live or neg .-13) thermoelectrical character. Later my estigations by Schranf and Pana. but shown, however, that the same peculiar a belongs also to glaucodo. to a dyante, skut gradite danaste, and other materias, and it is demonstrated to them that it expand be dependent upon crystalline form, our rather upon temical composition.

### LITTERACTION\*

Phytoelectrically, sic.

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<sup>&</sup>quot;See Lasterth, Phys. Revetalographia, 1891 for a fit the asion of the topics breathto the down to the precedure cooks, else for recovered to my to articles, also Tutton, Crystalography and Practical Crystal Measurement, Vol. 2, Coupler 49, 1023.

### 2. MAGNETISM

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<sup>\*</sup> Pogg. Ang., 74, 348, 1868.

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## VI. TASTE AND ODOR

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# PART III CHEMICAL MINERALOGY

# GLNERAL PRINCIPLES OF CHEMISTRY AS APPLIED TO MINERALS

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477 Typical Salts. The commonest types of salts represented among

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explicitly to hear a support of this work

478. Norma, Acid, and Basic Salts. - I ne tral or mind soll or me is which the basic of active congress law complete year or rections or or or in other words can be the type already given as examine in which is the by grogen atons of the goal have been replaced by the age atomistic real as or the transplan as have been completely topland by the and raded This Kast, ment a police unit a light but fillers, on he ther har fi is and por essum waphone succe in the actiff structly one of the body of a t kep by the base the mit put whem halts it that he are talk bed as to The Coup to a che coses as a be written as if I comprise to the west frames will take at , this frither arm given highly (1 see,

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481 Formulas of Minerals. The stricts on pireal formula expresses the key and may be seed atoms of the character present in the givent component with a citient of the way dead for each reservoir the latent are computed. These in the case of zone is the computer of the main at the atoms where the atoms of the strict of the main with a winner to the association of the atoms where the atoms where the component is the atoms where there is sent to be for the property of the strict of the stri

Again the employ, tornedle of corner apolitic of Pyle built that is not in Califord PO and arrived to the program of a display that the cold PO at that w, II, PO and the program of a display to the proceed by four to account to their wall to be another kind of apolite the relation to the notion of the same way Senderly to the the fortices of pyreproced case P1 i Pb, PO and syntamine (Pb, Califord Pb, Cali

harder, it is the observations is enabled the research writing the formales in voges in her the observations, seems 1 or example.

CaO CO<sub>2</sub> for CaCO<sub>4</sub>.

St. aO Al-O<sub>2</sub> as O<sub>3</sub> for Ag-ShS<sub>2</sub>, etc.

3Ag-S . Sb<sub>2</sub>S<sub>3</sub> for Ag-ShS<sub>2</sub>, etc.

It is a langer believed a swever that he moles that groups CaO, Al<sub>2</sub>O<sub>3</sub>, ore, actually exist in the mosconic of the subscance. But in pair occases these

groups are what analysis of the substance affords threefly, and in part because so easily retained in the memory, this method if writing is sill often used.

482. Calculation of a Formula from an Analysis. - The result of an the visis given the proportions, in a but gred parts of the man rel, or edger the elegated a broughtes or of their oxides or other compounds outlained in the chen, cal analysis. In order to obtain the atomic propertions of the elements.

In one the percentages of the elements by the respector again we make t, fee those of the earless Direct the persentage amounts of each by their MOLECILAR WITTENTS, then find the respect ratio in whole numbers for the numbers thus obtained.

Exemple An analysis of beogreeous from Wolfsberg gave C. Bromess the rest to usto heavy. These percentages are a discrept to stone weights, as should all g informations about a last a form or information goes or send 1 3 1 1 Here the the ladenical in that bolds, the theoretical values called for by the furnament are person under 41

Second Promple The mean of two and one if a garnet from Mask's gave bounter the residence or section after an end the peters, force over a to he section at a contact has be to MyOn our are good parents of these on the one ents. These an extra are a different causes on fascer tigother and the rail off months and months in the a second support when to the form a set of the policy of the first and the set of the review of the IN KINDS A SOVE

It is necessary, when your small manes then it y of certain eletions is as MoO, MgO Cut), above the transfer to sugger, there is the formula, reek in gills is a sub-the demonstration of the many painting are. The legree of corresuffered between the annual and the fermula value of the latter is entract a period of Atpenus entirely upon the scouracy of the former

483. Isomorphism. There is compounds which have an apalent is to appear on and a closely related cryst danc form are estimated sate to be rsom phases. This physiometon, called isomorpaism, was first rightly awagt out by Musschertich

Many examples of groups of isomorphous compounds will be found among the rattarnts described in the fud wing pages. Some examples are mentioned

here at order to eligibate the subject

In the brief discussion of the periodic classification of the channeal disments of Art. 467, attenuou has been caused to the prominent groups attended the elements which firm it slope is compensed. This collects has im, and strendlind, and one sear form the two series of all a group counts while.

Aragonate Group

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Proof () certainte

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har are to be good a true with a controp on some of a the vapuage there is properly or an agreement to grow the profit perifting I to are I be present and course and testand briggs of the epited el rutera for a socie a le tre e grop, can be could have con on the magnetic ages of Mgt 1 feet to man Mr. 1. These different many as that seems to the granular course father transferd the safet full to a spother compared to the option of the organic but the first setting and the organical of transferate on a seep Algel Oradia had the in the act of each district toy prepared to the wall on true will extend and a weet town of Mart ), properties of the contract the of these latters are described for the as ignor a top at the at an it will all deposits form to have been assegned to a property weapon of these completely property and a second of the total of resistances comment a page and the contract court of the agree of all the advanced the end nest year at table to a district and a south to contracted at, and the some replaces to the first of the Algebra, for each b west, or a transport date bett Warter at the aboverse of the court of the father enter the regime it were it the first of tsonsorphous replacements.

The lower for principles whether we able it expects when it are retrieved to the or open a positive for a fact of the representation of the plane of an interpretation of the plane of the

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Isomorphism in the broader sense in which the were westerned by asset in the broader in the broader sense in which is were westerned in the content of the asset in the property of the content of the co

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illustrates this point.

484. Interceptions Mixtures — It is proportional to part that the proportion of the copy of the copy of the sound of the proportion of the property of the sound of the property of the sound of the property of the sound of the sound

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Here it a second to these or points become the and apole continuous in the critical arms of the critical arms of the critical arms of the critical arms of the process of the sempolities, etc.

<sup>\*</sup> find an owner of war classer or if expert are we are chem a composition on M. Collections, Trans. Survey of 26, 1 lbs. o. M.

Further, the Feldspur toroup in the broader sense includes several other species, conspects as a the monocame orthodose KAstr.O., which, though becoming to a different system, at II approximates closes, in form to the

terrate de long

485. Variation in Composition of Minerals. Isomorphous Replacement and Solid Solution. The area that a natural point rigidly confirm in its etrope remposition to a theoretical composition actival from its form an a more gert's stretty teld. It a mouth it to make ny of mylegale dust by to on to reason between and though continuals within the arriterial pagentide errors in the grad, see win it if they hard, or as marreds show singlet and Mr at one constant variables from the r theoretical compos, one, These was to the control of the explained by the principle of isomorphism An in- there exist the is the case of spheretric. A tempore man says and deal be one may the serveral gos of rape things should those of ronge trespected ug v morease. I is earless these at dives that is round as a much smaller degree other root de may enter u to the choire a compound and while replacthe the aprepart in the same function as it, in the ervers here are treef the Hateria. The re- a therefore spoken of as tweet gase morph as with at zinc or the rouse to the me centure so virit as weather and sufflide nodes to. There is no led more to be between the up made of the gop and sine that may he present but stere is a cens and ratio (1), between the same of the a ones of the metals and the at resof supleir That is, although the con position may years, the stopper ration and the crystall ac seructual of main constant some cases the increb age between elements of redeals may be complete, in other cases, here may so distinct him at ass to the amount by sometiment coment or radeal way se replaced by an ther bor met mee in spin error the massaure percentage of the ison orphone iron scenes to be about 16 to 18 per cent.

Unfortens Aphalemia	Brown Sphylente	Harry Spladeste
3 22 23 2n 68.09 Fe 0 12 100.03	8 23.30 24 00.36 Fe 30 32	8 35 25 20 50.02 Fe 15 4 Cd 0 50 Pb 1 11

Further, we have eases where a compound may in a certain sense, desolve as their invelated substance and form what is known as a solid soution. This kind of pherometer on its well recognized among artificial salts and has recently been defined as proved with our in monetals. For assauce, it has been shown experimentally that the artificial roll sulph by Fish, corresponding to pyrrhot to can desorve an excess of supplier up to about 6 per cent. Natural pyrrhothe data was contains and excess of supplier up to about 6 per cent. So before the formula, less and var our formulas of the formula, less and var our formulas of the formula term arrival to also are as its maximum about 6 per cent. In view of the experimental data there as no dealt but that pyrrhothe straightful or considered as the monographic of that containing varying start amounts of excess supplier in the form of a second at the last training formulas of a second action.

An ther case of soud solution is undoubtedly shown by nepheate which examinantly contains a small excess of SiO<sub>2</sub>. It is very probabile that further

estigation will show that many transmiss have the power of belong a term, a small structure of fragge as set togeth to the term in the term of the ter

486 Codudal Minerals or Mineral Ges 11 him here registration per this court, white tell the forest substitution in to the sensity he was a complete to us at 1 and the regarded to fee a distribute of the plant of the property of the property of the property and the state of t and the term has been a moved on the log afternoon, to the last three for most a to style to which have the set, there is a recognition or at size I be a graph of the first and the state of t part sterry and the section of stelling the as he waster, take the carry set to a mark the set of pro- of I right wide the bight we and there are no within the open the and the collection of the a to a feating to the water a second of a material and a second of the s to I livy me over tend show to to cover of an ench tenger to be the france of the parties of a sea to enter the age of the manifest come as an afficult to a hard great that that of the more as the party as might are were have a lettere crystalline structure.

I town it ment goes are formed at low ten perstates and presentes and tree clar denotes, a found and up the presents of rock was borne at 1 in the up at the state of are deposed. Supposed the state of are at a personal lates the are is optioned as a supposed the state of the are in optioned at a supposed the state of the area of the state of the area of the state of the area of the area

Out a partiant character of the green turnends is their power to asserb forbut natera we II trough works the gentreer that my I thought trago, at any been a post of the water out out the out or or against man world to a rehere. In feel and portuges the dreexact visiter ed to exert a storing is were of a court in the agency and a data grain makes we have a single asset the to early a a horse a soft parameter, so year, are mangered for the operator read that pull of the common and advises a resolution of the temporary of an incidental and the first building th the rection of the garden to ed a terms, to the security Sales of the first that the engine is a first of the firs the total or product and the party of the phose, but and arrest ato greater the designated above we ware that of fest came but write now the coverage one (orner are to got to exact for exact the wine outling stand of tagaste he he go, form of he truzgo, to stophospherate as the gel form of good to. of a social of dioptage, and further give new tox ies, such as get a serte, for south suite, etc., to the gel phases of the corrects taking crystamor unp-427-0429

<sup>&</sup>quot;For a resignability the entract of petro careals and a complete of agraphy reference as trible to articles by Mayor and it one anger buster units Monk as not 3, 1 at a 11.

487 Dimorphism. Isodimorphism. A chemical compound, which creek a tree it work the gradients that bot, is an in the dimorphism, if it there is completely as, if it general programs that I is photometric to called the formal of a tree partial time to a photometric to called the formal of a tree partial time two substitutes process. This process is the partial the partial time that the two substitutes process. This process is properly as of a numeral least of a substitute apon the court of the first tree are applied as the creek, street its

A virible is given by the controller of the car white (at Opt, which is the probability as execute and as arige it. As each of error alliers to the check state as of the flex generality of and an entire terminal traces.

The controller is the probability of the same and the same are larger to gravity. The have all the same according and the same appeared entire the same appeared, end of the extinction of the same options whose options characters are the same appeared to the same and the same appeared to the same appeared to the same appeared to the same appeared to the same and the same appeared to the same and the same appeared to the same appeared to the same and the same appeared to the sam

We are expressed to give the fitter and downly. The partners that species being caused reduce, terruption,  $r = \frac{1}{2} \log 42$ . r = 4.25. The fitter appears in two forms, and it and an express we content of r = 1.75. Other appears in two forms, and it and an express we under f are it examples are problem and marked at (f. 25) sphilter can write, and  $L_{T} > 20$ .

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488. Chemical and Microchemical Analysis. The analysis of the

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so I be a nevertiger one I this character. The err a minimum peoples, a sea upon a a shall have supray to have been and to be start but and the season was Marris Mere than the state of the I as her Man ( s. a. of a One ) July I are of . 1p. [ [4,1 % 1p. b. d. d. d. d. ] p. + + 1 + [12 at the state whose the remaining the state of the state o

489 Use of Polarized Light with Polished Opaque Minerals. 10per and refer that open is truck by a sea to a larger of two rewat a defined a reward through the read to a company of the and a major esterologistic time in a set the annual set of a firm a lared supersons of the age of the first profile that a strangement meterile It the cost reason and reality and no or a trained to all attacks to the standard of the standard to a second of the record But well after the contract with t or print for he person que ferrore de presentation de la ferrore de la f two season for the charge against the entry were to The state of the s to the comment distances as a fire are the are well in the the the male stand of the standard of the stan to e at 1 where transports in the property of the feet is The sent of the same of a region of the sent of the sent of the e com persture a given to shop a dia 825 1 stan sur, pp of A 807 . 1931

490 Mineral Synthesis. The occuration of cort r i air, cit p - c, the little of aircing the jors, the time of the tree the regime to set Both back to per a city as to see to the for a line level for the form of the form of the first of the form 1 . . 1 174 ( m et h. ) re t et ma , me featt et www.serstatementary with their to a total and a Liberte. a a Cregor lear ton y Warrager a town of the red to the system on and a created to the party of to water all respect of the Man Charles of the Man the ter ter particulars a tre good can be delicated to experience in material be to service when there is not been serviced as forms present the exemple of the second of the second of the second a sea summarised and to the description of the meta-fac-

nunerals in Part V. 491 Atteration of Minerals. Pseudomorphs. The torical corre-I to the queries of territory of a relation to the contract of great arts and latteres parts to we then I began by the transmission for a sector of the hand the theoretical fact has to the to region go . . bet a trop property has after a court of the 2"8 , I'm to a por may be from a peter described to the fletter and period periods. thorpto. I end a ception in consort in the occurs be wis-

1. Pseudomorpha by substitution 2. I see amorphs by an open aspendices, and either by a netword or r (b) suffliration.

- 3. Pseudomorphs by alteration; and these may be altered
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2 Pseclomers has the result of Cricia less important class. Such are the crosts of specific forms I over a roots. In rest cases, he remove of he origins a more flow grades as it are roll goth the deposition of the second of the the root in a second croph is properly one of subscript. In particular, the root in a second or cavity and by the removal of a cristal loss been incorpos by the defect of a cavity and by the removal of a cristal loss been

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The course of processes in very most, high specimens will apply the period of the second to the course of a get on the course of reach and a local period period on the constants in the which they are been formed. For a terrature of the subject see the entroduction put. Book, Beschoff, Rose, etc.

# CHEMICAL EXAMINATION OF MINERALS

492 The complete investigation of the chemical composition of a finite of a children first, he described in not the elements present by qualitative attackers and, secred the determination of the relative anomals of each by a structure analysis from a late from 1, as he a chanted. Both a degree capital set in fig. 1. I for the eq. (i. ), as he assumes laborators for a previous at the analysis, however can always be made that, at 1 and july with two conventions. However, the methods can be the use of a the appearance of a the appearance of a the appearance of a the appearance of the heart with all sections with the green applying to be trusted. Some practical matructions with the green applying to be trusted.

## EXAMINATION IN THE WET WAY

493. Reagants, etc. — The most common vierpo veri chemical reagents are the their content reports to proceed, no, taken and a plant. To these ray be taken common to their area of the following the rate of the reacher the number of the process of the process of the rate of the rate

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ete.

(b) Solubility with efferences takes place when the inneral loses a gases in agreement, or when one is governted by the most of reaction of cut and inners. Most conspicuous here are the carbonates—of which descrive with effectuacears, going of the otherwise gas motion are let (10), though some I then, only when privaries, it igain, in the addition of heat. In applying this test dilute hydroche included is enjoyed.

Hydrogen sulphide (H.S. is expliced by some sulphides when dissolved a by tract on and thus a true of aphancia and only one of this gas a really recognized by its offensive odor.

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(c) The separation is an inadable ingretical takes place with many substates, the sile security substations is a 11-perioder and against a 12-perioder and against the against a 12-perioder and a 12-perioder and

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498 Examination of the Solution. If the princes, is off inthe complete of the period we could be considered to the period we could be considered by the considered of the second of the considered of the consider

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Agun phosphorus may be detected if present, even to small quantity,

but the ser bedet on if a miner. by the fine pelies powder which separates, white market stateting, where and much in Abba chas been added

## EXAMINATION BY MEANS OF THE BLOWPIPF\*

496 I'm see a the howings a swined hands gives a quick method of aging bytts show age of the panishs or peaks of a finlative the returning proving the province to the spart price

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497 Blowpipe and Lamp A good from of his ways British is told on one the fact of the essential. of periodic is selegated to the term of the tipe of At the second principle of the second of the I as total a short his configuration to be an and probability

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off the air supply at at the eas then burns at to be a title space on flame. This flame should be one to one and a half inches high. The tip

of the bis papers have according to some soft in the flour see tweet and the next was the girl causes the Harpe the the spent up to big of the



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nearly the magazine two to we of 498 Forceps. Wire 1 at a graduate of a real cache . plated and should have spring a chief them. support femily the man-

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<sup>&</sup>quot; be a part the property as they are the er alle a light of a form of the se to be the set of the set, the set of proof 1 2 we have ago with an extent to a little yet had no in fact and his to

fragment of nameral between the platinum points at d. The steel points at the other on tions used to pick up small pieces of numerals that must not be asserted a the fame. It are must be taken not to injure the platinum by allowing it to come in contact with the fused uniteral especially if this contains antimony appear lead etc. Cheaper forceps, it mie of steel wire etc., while nel se converger will also serve reasonably well

A short length of fairly strat partners who to be used in the making of bend tests at hid be available. A summer length of finer were for making

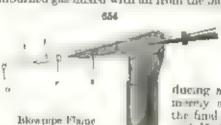
flame tests is also desirable.

499 Charcoan The charged employed should not samp and should yard tout the user the Kinds made from bassword pune or willow are best, I is mos or hyerien in employed in rectangular pieces, say four motors long, at luch war, as t have marriers of an inch in thickness. The surface must always be perfectly clear terfore each trial

600. Glass Tubes. - The glass tubes should be preferably of two grades a hard glass tubing with about 5 min, interest diameter to be cut in five sich lengths and used in open that tests and a soft glass tuling with about 3 mm

interior d interes to be in about six inch rengths, each length yield-IDJC 1 West Carrond 1 Types

501. Biowpipe Fiame. The blows pe flame shown in Fig. 654. consumes of three cones on inner of 5 one coor, c, a second pale vio or come, b, and an order aviable cone a. The cone c consists of unburned gas moved with air from the allow pape. There is no combine



tion in this cone and therefore no heat. The cone b is the one in which contribtior is taking there. This cone is riving earlies monox is which is a strong re-

ducing agent ser below it one a is marely a gas envelope composed of the find products of combas ion of by and Hat The heat is most intense

hear the tip of the cope b, and the mineral is held at the point when its fionbildy is to be tested

The point o, I g 654 is called the eximitino riams (O F), it is chargeserized by the excess of the extigen of the air and has hence at oringing effect appear the assay. This flame is best proclams, when the jet of the blown no is paserted a very lattle in the gas flame, it should be entirely honhama Penak

The come has only the agencies many R.F. the characterized by the excess of the earton or in accurbing of the gas, which at the high temperature present tend to earline with the expans of the mineral tree glit into it a, e), or, in at ar we can be coursed. The less remains happ to produced when the ble wrage is bear a bride distance from the gas flame, it about a retain the velow color of the laster in its upper edge.

502. Methods of Examination. - The bi-supple investigation of minemis melanes fear examination, (1) in the forceps, (2 in the closed and the open takes, (3 ), chargens or other support, and A with the fluxes on the

platinum wire.

#### 1. Examination in the Forcepa

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504. Pusibility. All grades of find his exist among uncertals from these wheels these in large frequences in the father of the could be seen at most otherwhich for only on the things colors in the housest thin paper than bronz co., and still again there are a considered a number who are extends infinitely (e.g., rectal) the

The exact determinates of the temperature of finden is not easily accomil her of Art 443, p. 502 and for purpose of leterin have a fisheres is allocased. The approximate of the degree of and artists that a large by

referring the morrel to the following scale suggested to you avoical.

1. Stahnite.

4. Actinolate.

2 Natroles or Chalcopyrile

S OF HE WAR

3 Almandite Garner

6. Bremarte

605. In connection with the trial of few of ty, the falls wing their menta to a be observed, a consistent of the flow are Art 506 to a configuration of the mass rad very cut of a governing with the country of a governing with the secondary of a spirit good of the mass to it tues secondary.

The cover of the mineral after ignit of is to be no ed in if the mature of no fused mass is also to be observed, we not a leaf of bothly goes so decrease in his kind, who a nother the best of restrict a tragger of start

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esicium, bartum, stronttum.

506 Frame Coloration. The construction required to the atternoon per flar is while the representated on the frame is being latter, brakes present to be depicted of a register of the errors.

<sup>\*</sup> America antimony and easily reducible diction and and cupper form pure in

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# 2 HEATING IN THE CLOSED AND OPEN THRES

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#### Sublimate in the Closed Tube

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610 Open Tube. — The sman fragment is placed in the tube do it at we form the lower end he its being signify and well at 200 to the descript to make the inners to up a still has appoint but in the form of an exempt appeared brought to tube during the new step process has an example effect. The special placement is a consistent of the order of the escaping gases. The anider is a make an interest in the control the same with the country to the interest of the control in gas to be interested in his with a supplied to the interest same being excluded. This gas is at he next an example of the end of the same with the control in the control in gas to be interested in his with a supplied to the interest and its inext result, in a per it was exactly a supplied.

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# Sublimite in the Open Tube

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# 3. HEATING ON CHARGOAL, ETC.

611. The fragment or provider to be exhibited is placed near the end of the piece up, this so has that the bound passes doing its eight to be but end of decrept described in a be provided, unvertiwed wear, and that on uniterial employed as a paste.

The roots og family omphand if a is desired to reduce, mutal by silver, corper for a source that a silver case. If however the increase with he resided had to be added for the whole of the area ple the sulpour assumment to provide the exchange flace is to select and the parties of the representation of the provided and the parties of the respective operators.

The product to be boded or as follows

a The odor given off after short heating. In this way he presence of

adphar graens (garlic or siluceous edor), and selentian (otler of decayed horse rules), may be recommed.

I have been been the case of the salts of the alker as the fused mass is absorbed at the thereon. The is also true after ving a sting, of the car-

otheries and suplates of harron and struntrum Art 515.

The Note much - By this means the presence of many of the metals new because manual. The color of the sublimate both near the assay N) and at a discover D to also when but and whom colors to be to ed.

The maportant subarrates are the following

# Subilance

Arbeine thosa ar AsiDs

Antimony oxides (\$5,0) and \$5,0),

Molybeiman trioxule (MoO<sub>4</sub>)

Louit oxide (PbO)

Bismuth trioxide BisOgless

#### Sublimate on Charcoal

White very valuable, dissume that the usery, also earlies turned

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To the above are also to be added the following.

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To read to a fail for a strong entering whate N to gray I as R I valuables with strong to

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(f) The Infusible Residue—This may (1) glow neighbly in the 1 ft, indicating the presence of substant, strontian, magnessian, and a house out on (2) It have give an abstance reaction after ignition—also her artise—(3) It may be recently as with the presence of inch or trace —(4) It may yield

a grande or throw of a court a three 513.

512. Heating on Plaster of Paris Tablets. In some past is preferable to be not gill insules on the surface of a paster of Paris against their early on charges. So that the gill is easily need by spreading a thin aver of the wet paster upon a glass plate, the surface of which has not easily more in strong pregnanting that a the gill is so in strong an appearance that a the gill is four a ties. After a planter has hardened these can be broken out at a the desired tablets. The to creat the respect to planted in a small term of the tablets are the second of the blooding cannot be in the case of charges. The market of the paster tablet. These are olderned water either overlinder and or a first controlled a movement of petasse to relate and such market of the paster tablet. These are olderned water either overlinder and or a first controlled a movement of petasse to relate and such market of the return powder actors being. The important and market have

<sup>&</sup>quot;A toched by which a bit area are formed on absent of many has been described by Brally to Black one Man, 44, % 1921

#### Substance

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Le gram gale Teller

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M. Schenos judice Mali

#### Sublimate on Plaster Tebiet

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then so to real Disappears when susperted to ammonia

513 Reduction on Charcoal. In many cases the reducing flame moties suffices on charcoal to separate the motion of motificial to the result of giving ground or more lemmase. I have a true obtained from argumpte Ages, and consequente Ages, appear from the leave Chapset I protected and the Lagrangian of the subject of the process of results to subject to the subject of some section of the contract of the contract

Les \*\* Les ( . ( Les ! ! ]

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the metal present.

Bit. Detection of Sulphur in Sulphutes. By means of some on charcos in presence of sulphur in the sulphutes must be shown, in I for a or manner from the perfected majority with soils and concernal last. Lack majority from the perfect majority with sulphus to a sulphus with the formation of soil the approximation of from the perfect on a contract such a temperature of soil mass is parent with a trop of water upon a contract or with the critical substitution of soil or sulphuse. The later can however or relates distinguished by reasoning in the open table or upon charcos, and noting that maintains of 5th.

# 4. INDATMENT ON THE PLATISCH WHEE

615 Use of the Pluxes. The three common there are been and of phospherics, and carteens and soin puth). They are generally used with he plus num wire, can often on charcias, see above). If the work is employed it

m of have a small round loop at the end; this is heated to redness and dipped into the powdered has an other harring particles found on their the operaline is repeated intil the loop a blied. Sometimes in the use a somethe wire

may at the be moistened a attactore as it to othere

When it held is rect. It is whose it, brought a contact with the powcered in new, some of what will interest to t, and then the heating process may be continued. Very title if the innered is in general required and the experiment mount be not mention with in the equal to and more added if the some. The beauting to the bested is reconsidered him in the explaining disme-(it) is taken in the red long time of the and a such case him in the explaining with the aid with model for plant come controlled with fusion, if a times place, must also be observed.

Moreover the part of the many or both to get be first regard need the the season of th

We had so taken been a ting wire she if a he hard above he flame so that the examing

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516. Borax. The following as context the affection related breas estimated with some or in the excitating () I and reducing times R.F., there is the first time of whose sees to colors are due. Compare farther the reset to give in the new dichects Art 518.

#### Color in Borny Bond

#### Substance

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#### 1. OKUPIZING FLANZ

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) ellers

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" RESPUEND FRANCE R.F.

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Colories (ted Creen

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With minimize this flux forms a glass in aboth to bees if the sil cute are assolved but the silves itself in self-nechable in appears as a shearten read by

seep fleating about in the merted best

The colors of the beads, and the metats to whose oxities these are due, are

Color	Substance
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3 dlow	Mark to will prove the paler on cooling — (in R.F., bot, paler on cooling — (in R.F., int, greet of a greet of a R.F., but yellowsky greet
	Years of the last seem but pales on on on a RI
Viouet	Thomas to be as both, risk but have and by yourse dost substrates, cold

## CHARACTERISTIC REACTIONS OF THE IMPORTANT ELEMENTS AND DE SOME OF THEIR COMPOUNDS

618. The following lat contains the most characteristic relation of the before the howeings and in some cases, so in the see was of the integral elements and their modes. It is except to be a the togeth them as with them has truly with as many a depath to possible. Many it them a vealure as been truly in the median the presenting place in the result in all descriptions of these and description in the second to the versure by Brust and Penticle referred to a p. 361.

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#### DITTERMINATIVE MINERALOGY

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# PART IV. ORIGIN, MODE OF OCCURRENCE AND ASSOCIATION OF MINERALS\*

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521 Chief Modes of Mineral Origin. I From Fusion. The gaster that 4 for plants a that to be for the first of the energy days been to a particular to the first of the form of the first of

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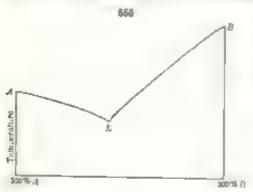
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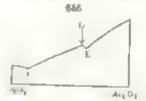
<sup>&</sup>quot;When he is a northern which became a more all and the gentle in a registration of the proof of

which the various elements present are more or less free to carculate and under the proper conditions to unite to form mineral morecules. The composition of the magnin wall friend me in large part the character of the minerals that compose the resulting trick. By the study of the used is of analyses of igneous rocks it is shown that the following constitute that, 99 per cent of the extuelits present; oxygen, sileon, and and, trop, magnesium, calcium sodium These elements occur in varying proport on in garous magmus but the constituent minerals of greens rocks are composer essenting of them. The cor of a 68 under which the various minorus are formed are onemex. They crystal in from the country is sent a in general in the order of their so ubin less. Although this order is a fairly defineds, he the variet on of the element composit in of the magnia will vary as degree of solutality of the various manage, court then have a true vary the order of their crystal in-The Bunds was the margins and the tentional are at which various minerals will creat, lize are influenced greatly by the common presence in a magnitude of spial, amounts of si winness that are known as ninera term usually was er vapor earter I by do fly time by the and suprint and chapting I some extent these en er and the ean program of are us ruch making theberns, but the nie they play in the formation of gneous norks is upper a physical one. It has for not once here shows experiment any that quet comnich rock quaerais as one wase acree and quarte car cure, a formed from a try fusion as a rise was uprayerally sat glasses we result to such a reaso. It is not in the presented water value of it he temperature if crystainzation is sufficient a lowered and the fluid of the matter and presented so



as to permut the ready growth of

When two ministeners (A and B) are mixed together in various proportions and then fused, the term are are of soldification of the mixtures are in general



la log cook the percentages—the methods of the part of the part of the log cook the percentages—the methods of the Both percentages—the methods of the Both percentages the methods of the Both percentage and the term of the time of the Both of the percentage of the percentage of the percentage of the term of the Both the percentage of the compound to the presentage of the compound to the presentage of the compound to the presentage of the percentage of the pe

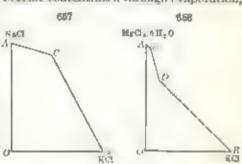
 $A_sB_s$  and  $B_s$ . Such a condition is represented in Fig. 656, which gives the fishing curves for mixtures of  $S_sO_s$  and  $A_sO_s$ . The point c is presente the mineral similarity,  $A_sS_sO_s$ , and the points E the effective points on either are i.f. If there are two or more possible different in second recommand on a A and  $B_s$  the curves been nemerosating c is upden. It can be readily seen that if in addition the fused mass c is the rock magnine contains, as is unumy the case several different chemics, components the problems involved in the creation of of the constituent innormals of the pokes are enormously difficult of solution

There has been in recent years, however, a great amount of experimental investigation concerning the behavior of various systems of oxides under conditions of high temperature and pressure. In this way our knowledge of the physical and chemical processes involved in the crystalization of university from rock magnitudes is being greatly extended.

523. The Formation of Minerals from Solution.

1) By the Emporation of Solution is the Figure 1 (wear waters and the waters of salt lases contain various solution, when such waters become concentrated tarough exaperation,

certain numerals are deposited. The saline content of sec-water to composed of the filter given-strate it. Natl about 78 or cent; KCl, 2 per cent; MgClz. 9 per cent, MgSCl, 6 per cent CaSO, 4 per cent, When such waters are evaporated, the above salts, or certain combinations, 6 it as carna are, KCl MgCl, 6HgO, crystallize from the adult of its an its order of their solution. In general, the normal



order of crestall zeron is as follows carbotates of line and magnesia, calerin sulph it seatum colorate, magnesiam choride at surplate, petasorder of the variets constituents in the seatten car of the claracter of
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\$24. Occurrence and Association of Minerals for a 1 translate with a party of a party of

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The following paragraphs describe brown the more important modes of mineral occurrence and the more characteristic types of mineral association.

525. Occurrence in Rocks - A though many minerals are four i as rock constancents those which can be termed common and characteristic rockmaking unperass are comparatively few in number. The femality on the comes in such species, and text of these wour only in rare rock types quarte, the easpers, nephen c, sain 'e is eite, the nieus the pyre sense the an pluhe as chresolite kanlin, the chlorites serpentine, the, calette and folumite. In a life was the too me in portant and countries were making minerals there is a group of honoraid which are man crosses can't found as not a constituents but in a morar way likey order asia v may as affectly and appropriate if the rock and se, I to become the of a prome constituence. These authorals are HI we as accessor, and may be mercue. A great many effecting to the er of their fit I mes occur is not sure in technical taction, but he felium og usta mer, be to these that characteristically occur in this way. The store of fution are gurnet epithote at a first to available appears thanks appeare. The folmin, it are at their manufactor of the its areposite an identic elliminate. In a companies of the month of the mention of the month, and pante, also Bigt what is appresent back it because

526. Igneous Rocks. Igneous tooks, as the name understee, we those which have been formed in the cooling and consequent sole feature of a one hot any final trease of took majorial, which is known as a magneticeed Art 522. In most groups works a more of less tefante order of crystalization of the mosts come of this scan be beginned. In general, the core base majorials of those with a mount the structure are this discuss which is the need closely in give as these are found to the contract of the feature are majorials and the respective formers. The following with a thing to come contract to and there is no following with a thing to come our contract to and there is no following with a thing to come our properties, there are properties that the properties that the formers he following with the former appears to the mount of the contract of the contract

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# Plutonic, Coarse grained Rocks

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# Volcanic, Fine-grained Igneous Rocks

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527 Sedimentary Rocks. Sol property parks are sound for in their crigate the most cate of with the type consequence to any time derived found the next of the degrates of some for it is extend in the second first here been forced as a depose on if so arranged and it is not they The first state of a superdistributed by the compressions no lamped of other to B to come In the case of the secure of backs meeting out they cannot not part out to be not form the I stegral in of some back to see a first best trainer I a craw a first B. Re tady of the water water to be been and the contract to the to proce a location beginning that the contract of the contrac to end which they are empressed how and it wo in the right my time of the rocks and brought diminitely by these waters and a sea, where they go a me

chemical change it leviate precipitated upon its flow, also in horizontal layers. These of the sold selfments are ultimately consendated into the masses known as settingent in rocks.

Setumentary rocks are therefore characterized by a parallel arrengement of their constituent partness into livers and notes which are to be desinguished from each other by differences at highness size of grad and then in color It is to be noted turn or high-lanether rocks to extern are composed of an aggregate of it is to one have that intimate total decling reason with the sum during partness which each to seen in the influence of an guessas rock. In all, the course grained sed mentary rocks were as some informal which, acting as a company, a gradual to be invited in the partness of an index the integer bet. This essential search is a sedimentary rocks are quarter in la carbonate course of minutes, and be touch in sedimentary rocks are quarter in la carbonate care or of domine. These give his to the fact that types of sedimentary rocks, the sames of sedimentary rocks. A rock tescrip can of these turks follows.

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4. Other Notements by Firmations . In thest of in the way mentary michael St. J. of the ter arm g to large market are visit and matterns that have been pro to steel from which say are Art \$23 Kink and per tre with the the end as a part of the sector is an acres and at many 1 months give agree her zone lits beds vary in a canes from con to more an long housed for toposite two occurs a many process and a topic to the break [1] comments and more as and the response a speciment will report the and at a denotrie, though reserving a telegratement is found it deer AND LEFT OF LINE 1 IS NOW A PLANT OF THE POST OF SOME OF A 48 HEART COMMENT. to be not most and from that spirit go either and the experience of the world of which are t act, to dage with a maje trem the want na contractor for tensor of contract a submission of rocks at the energy formed from the sales sky one of ear te day does that the drawner At these sectors in to a not deposit reasile on a life arm, one appet to him are upol saler to make of he in sec. that is book our littler on her or along the inof the reduction species or certain regular, beds of principle each mi pi es tates, kie we as phosphoric it phosphale lock, occur see titaler apatite, D 2 14

628. Metamorphic Rocks. Metamorphic rocks are rocks which have are egone some convex or physical charge at sequent to they original for the man and change has been ownigh, about to notice if agritor perat by at I t presents a ter, ha the action of water and other chemical agents. The horsemplance the most of him note may be often or a tree or g of chief all considerate and a physical read, stream of the trees, particles tions, and to the capacity presents. The original rock from which a meta-Post to neck has been been of they be en as given as it seletteratory. As a make because it, and in its rements of an existing order their new expected to extense pressure accompanied topology to high temperatures. The rese than to tree and to the range on the case may be a majoral anothers. ment was be a fer the six channels. A weigh many process his maps Contaillustra fitz or En to mak this stin ca. The west to be a property to so we an about the transfer of the entert on the part during the progress was in the discress per earlier to the attemption rocks are terry in the or late known a manufactual that it had good to be great harter. The primary structure of the neck are not in his rily be enabled. during the opinions. He again of the proops or to at it the reach it such extent er where parties with more or one when and that ones at a marranged in paralle, andre II shet has reading ed chara tor give by the parallel arrangement of temperals is the next stricing per aline. In the uncomplice Ports. Hereauth of these part are a metado the come as he have a some freque an agreement on the fresh to the great to the trace a metal or make pook has a crystalaur structure which distinguishes it from a polimer tary rock

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529. Contact Metamorphic Minerals. When in a series route an agency -THE west the court of the same presenting exerting a contract to great substance of or as at a reason of the rocks and to X' a make a ferr - herestally es a page to part to the transfer of the disperse I have begree out it at a fatter part of a company to a fact of of the st here to the service of a second se promotes to prove more frequencing to the firm of " the first a state of the stat At lattice the strength, and at his strength or his warms or out many not a special of the tracks of the first terms ders are for my the fifth of the contract of the form to which of give to see or T and Ma, of the first first figure and the state of t 8728 Fig. 162 185 of an inches to complete the Watt dat 1 22 C a. s. often with agreem that the contract of the still of the growth has a contracted to the property of Were the property of the same approach with the first the contraction of the cont a te see to the sport than the field residence of Story grade Ash to the transfer of the party of the real of the real Are properly and the contract of the contract I arek very growth courted or are very the section the treatment to the properties in the concept and the contraction current to a fine to the second of the secon Act of open and accepted to the contract of Incres la leate to the start of a settle of the territory the property of the second of and directly was to bell as grown, a about the proof If any carbon con any transcript to their door to reptom rest tracelle a grade acte to the option and ers from the same of the same of the same teres for to the ter il was gitten, to you were

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# PART V. DESCRIPTIVE MINERALOGY

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534. Scheme of Classification. The method of bassification adopted to the varieties of the case with ranches of a to be the roughly sector to be that which is seen a problem and compared to the theory of the case and will a major the larger of the larger of the case and the problem of the case and the case of the cas

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In regard to the various classes of salts it may be stated that, in general,

ther are separated . This issue are a base and hadrons sections, the specia subdivisions in a fire cases it are in the liftered cases.

For an examination of the obtaining open of the rescription of species, see p. 5.

# SCHEME OF CLASSIFICATION

- I. NATIVE ELEMENTS.
- SULPHIDES, SELENIDES, TELLURIDES, ARSENIDES, ANTIMONIDES.
- III Sulpho-sults Sulpharsenites, Sulphartimorites, Sulpho-
- IV Halonda CELORIDES, BROMIDES, IODIDES; FLUORIDES.
- V. OXIDES.
- VL. Oxygen Salts.
  - 1. CARBONATES.
  - 2. SILICATES, TITAMATES.
  - 3. NIOBATES, TARTALATES.
  - 4. PHOSPHATES, ARSERATES, VARADATES, ANTIMORATES;
  - 5. BORATES, URANATES.
  - 6. SULPHATES, CHROMATES, TELLURATES
  - 7 TUNGSTATES, MOLYBDATES.
- VII Salts of Organic Acids: OXALATES, MELLATES, ETC.
- VIII HYDROCARBON COMPOUNDS.

# I. NATIVE ELEMENTS

The NATIVE RELATING TO I Asked into the inside the sections of the Melling III November 2 and his are controlled in a massive class of the seminaries. It is not in any on an astrogard physical characters and term if not as one attends some or Art. 466

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padadom and from An allotropic form of palladium and also indosmine (IrOs) are both rhombohedral.

### DIAMOND.

isometric. The development of certain crystals as well as riching testa have suggested totalt idea symmetry by. A ray study of p 40 shows that the atomic structure conforms to normal symmetry. Commonly showing octaneural, hexactahedral, and other forms faces frequently counted a structual and with triangular depressions on other. Twits common with two pl s 111) and often flattened paradel to o. Crystals often distorted in spherical forms. massive



Clearage  $\epsilon$  111 highly perfect. Fracture conebordal Brittle H=10 G = 3.516–3.525 crystals. Laster adamantine t gressy Color whith reck rises occasionally various pair slanders of yellow and orange, green, blue, brown carely deeply conored sometimes black. Caught transparant assometimes topic, at Restrictive and dispersive power high, index n=2.4195 (See Art. 334). Using a isotropic but sometimes shows anti-ential briefly gence. Shows at times brilliant phosphorescenes when rubbed or exposed to the electric discharge in a vacuum tube. To diffre-violet light, etc.

Ver, I Definery to create any all with manifed large and varying from these which are colorises and fee few a faws near the through many factor of a transplint when the second of the fall of have and hence a value in y for cutting purposes.

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Artif - Various ways have been described in which print to do monds have been I stored artificially. It has been shown bowness that at each to some cases, the supposed definition crystals do not present the requests retreated to to be a property.

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## GRAPHITE. Platelings. Black Lend.

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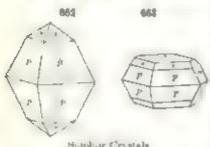
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### ANTIMONY

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Use. - An ore of antimony

### BISMUTH.

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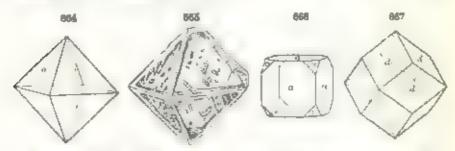
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# Gold Group

GOLD.

Isometric. X-ray study shows a face-centered culto lattice (cf. p. 26). Distinct crystals rare a 111) most common, also dillo and midll, crystals often elemented in direction of an estabedramaxis, giving rise to rhombohedramike forms, and arborescent shapes—also in plates flatened—will), and branching at 60° paradel estima to the edges or diagonass of in a face see p. 194°. Twins: two plane of Skeleton crystals common edges salient or rounded, in fill-form, reticulated dendrity shapes. Also massive and in this laming, often in flattened grains or scales.



Converge none Fractive backly Very under deat i divide H = 2 · 3 · G = 15 · 6 · 19 · 3, 19 · 33 when pure Lester metallic toler and streak gold-yedow, sometimes inclining to gilver where and rarely to orange-recompagner.

Comp. Good but usually alloyed with silver it varying amounts and

sometimes containing also traces of copper or from

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### SILVER.

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Une. - An ore of adver-

## COPPER.

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There are none Frontier backly. Highly describe and malles do: 11 = 2.5.3 G = 8.8.5.9 Laster metalic. Color expected. Stream metalic sharing opaque. An excellent conductor for heat and electricity.

Comp — Pure copper sometimes containing small amounts of gron, silver, business tim, hard or nature ty

Pyr., etc. — B.B. fuses read to on country brout as covered with a country of blank criter. Passol current on the only process group, of the process and produces a people acceptance of the control of t

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Use An ire d copper

## MERCURY. Quickeliver

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Comp. - Pure mercury 11g with sometimes a attle silver

Pyr., etc. | H B ent rest to a to vapores ig at \$0.1. Handwes on three to One Mayors to prix a stema ranguered to a days to are to p sing the remarkal appropriate with a proposal of the first terminal and the first terminal the complete and the company of the from but scours.

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# Platinum-Iron Group

### PLATINUM.

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Comp - Platterm aboved with men, problem, rhodium pull diam,

omnium, and other metals.

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# II SULPHIDES, SELENIDES, TELLURIDES, ARSENIDES, ANTEMONIDES

The sulph lies, etc., ful into two groups according to the character of the positive element.

- 1. Suiphides, Selemdes, Tellundes of the Semi-Metals,
- II Sulphides, Selendes, Tellundes, Arsenides, Antimonides of the

Nago-Ag

# I. Sulphides, etc., of the Semi-Metals

This section nel descript distinct group, the Stabilite Group, to which organizers is related the other species has idea stand alone

### REALGAR.

Monochine Axes a b  $c = 0.7203 : 1 : 0.4858, <math>\beta = 68^{\circ} \cdot 15^{\circ}$ . H", 110 A 170 - 68' 48

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#### ORPIMENT

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Pyr., etc. - Same sa for centgar, p. 4166

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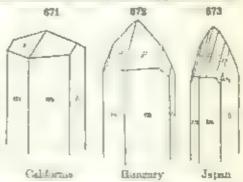
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### MOLYBDENITE.

Hexagonal c = 3 816 Crystals becagonal a firm tabular or short prisms signly tapering and horizontally streated Commonly foluted,

massive or in scales also fine granular

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# II. Sulphides, Selenides, Tellurides, Arsenides, Antimoundes of the

The suppliers of this second sector fall into four decisions depending upon the proportion of the negative content present. These discusses with the groups belonging to their six as follows.

## A. Basic Division

# B. Monosulphides, Monotellundes, etc., R.S. RS, etc.

1 Galena Group. Isomothern may 2 Chalcoute Group. Orderte note

3. Sphalerite Group. Isomether- rube iral

4. Connabar Wartzite - Millerite Geoup. Hexagonal and rhombohedral

## C. Intermediate Division.

Findences Bornite, 5Cu<sub>2</sub>S.Fe<sub>2</sub>S<sub>2</sub>, Linnuite CoS to<sub>2</sub>S<sub>3</sub> Chalcopyrite Cu<sub>2</sub>S Fo<sub>2</sub>S<sub>4</sub>, etc.

# D. Disniphides, Diarsemdes, etc., RS2, RA82, etc.

1. Presse Group. Lametre-partenoiral

2. Marcaste Group the horhende

# A. Basic Division

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### DYSCRASITE. Antimoraliver

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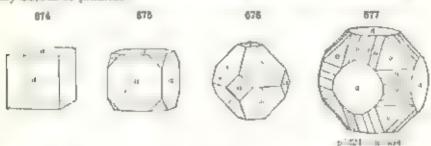
# B. Monosulphides, Monotellundes, etc., R.S. has, etc.

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Crookesite. - Scien do if copper and that am, also silver a 5 per cent it a, 17, Ag see Master ( a art a a fe ) Insteer or a a few trainings as from the same of

Springer near I'm sen in the man Sunder

Principle to the Caste Massis I engine dur to compact H = 8 C. = 5:520.

HANKEN HETE. Case orbits betagend and semorphone with cored to traine see Hant ten age. Subsequently of the Sustainant of the Hart Manager of the second of the Sustainant of the Hart Manager of the second of the Sustainant of the Hart Manager of the second of the seco

## 2. Chalcocite Group

		a = b	<
Chalcocste	Sec. 3	0.5522 1	0.9701
Stromeyerite	Ages Crist	Q 8322 I	(Lighton)e
Sternbergite	Ages beas.	0:5832 1	0.2403
Acenthics	Aust	1 6888 . 1	0.0944

The species of the CHALCOLITE GROUP cryst like in the orthorhombic system with a prismatic angle approximating to 60 , they are horse pseudobexagons, in form, especially when twittees. The great is part of to the Argert to Group, since Can't like Ag 5 has a high temperature assure torm and a to stemperature orthorhoustic form Some authors melick dyscramic bere (see p. 414).

CRALCOCITE Copper Glance Restrictate

Axes  $a \cdot b = 0.5822 - 1 \cdot 0.9701$ Orthorisomble

$$mm \rightarrow 0 \land 10 = 60^{\circ} \cdot 5$$
  
 $da \rightarrow 021 \land 021 = 125 \cdot 28$   
 $eg = 001 \land 421 = 62^{\circ} \cdot 51^{\circ}$   
 $eg = 011 \land 421 = 62^{\circ} \cdot 51^{\circ}$ 

Crystals pson lo-hexagonal in ang r, a so by twitting it pr no 110) Rarely twinned on 0.1 or (112). Office massive, structure granues to compact and impalpable.

CuS is dissurphage. Above '91' ( he atherhor he form changes to an isometric modification. And envirals of the latter show solvens betabearts with two same in 111

Cleavage mill(1) indistinct etching of orientated crystals developed cleavages parallel to the three proceeds. Freeture c action al. Rather sectife H = 2.5 3. G = 5.5.58 (5.7%) for antif mineral Laster metalhe Color and streak blacked lead-gray, often tarmened blue or green, dult. Opeque.

Comp - Cuprous sutpliede CusS = Sulphur 20.2, copper 79.8 = 100 Somethics in a in small amount is present, also silver

Is has been above experiments that the man take up to sold and then as man as Become the another than the property of the grant of antiseting

Pyr., etc. . In the open tube gives supplierous turner. B.B. in Large at mosts to a Elet the way blanca at the case of the case of the parties a single on only the color on the

front materials as the greater H

Artif that we share the test compared artificially by beeting the tapors of suprous of the world images or I see a sine treatment of rules or 18 will be drugged out to 10. that I white treat of the price of the will be treated a second to be

After I er o me e e per halespyrite bernie, over e remarkite and aggrite.

Paradomerphic after charge vitte sounte, pyrice gasera and materite



Obs. Thanceure is a very vacantile over it copyer and as witespread in the occurrence. The angin to a set the companies and the man me and the man me. It is not be a form my known a tot and or a make the policy tend on the extraor beautiful troop. from or teacon any paper rest is self-cross upon the magnetic in he requested the cross of the cross I there exists a perior objects a man an anather the or or or or or interpretato the second the masters. A third number has been described a vice to pay on any a south materially refer to the test that the etail is above on the me with the state open and the end of t to a fart of the section and begge to a first has with the adoption over the set Williams

Stromeyerte again a harmonia for the first contrated a creat is infirst.

Stromeyerte again a harmonia for the first contrated a creat is infirst that and the first contrate a first contrate and contrate a first contrate a first contrate a first contrate and contrate a first contrate a first contrate a first contrate and contrate a first contrate a first contrate a first contrate and contrate a first contrate a first contrate a first contrate and contrate a first contrate a first contrate a first contrate and contrate a first c

Venue costro , and from Curaci esc., in Optano.

Cabonite. Chal sessite. Cap.S. Prips. Orthorhomine. Axial ratio near that of chalcocite. In this closure at prisma, certically structs. I was even so with 110 as to presenting chalcocite. If I are to a timese to make the own strong of angle. Common was arise a learnest from the manner. I amble to make the process was arise, a learnest from the Morro wells got more. Mannet terms a first the Morro wells got more. Minute terms structure of the Morro wells got more. Minute terms structure of the Morro wells got more. Minute terms structure of the Morro wells got more.

#### STERNBERGITE

Orthorhombic. Crystals Libular (1991). Commonly in fundike aggregations twins, two plometric Chestage (1991) highly perfect from manage flowing, also find H = 1.1 r. G = 4.2 m. Laster metrical Copyrights below the Street black. Opaque

Comp. Agfress or Ages Fees, = Sulpaur 304, silver 342, iron 354

= \$(%).

It appears probable that area in I varying along its of Les and S may be held in a hill sociation at all the interest and organize great from J exchanged and a pay parter transfer book are varieties of standardate.

Obs. In is with for rigorite and stephants at John brasing Bohem a, and John his

georgenatudt. Sammy

Annutate were submine, AgeS, like argentite. For relations to argentite, see to let that agent p. 118. Orthorburne: In stender manner roll is See to Co. 2, 2, 7, 5, not present bound at least and another its enemy. Because heart breaking, and resember. In Carbanam and Zona cons. Memory. Reported in Contrato from Georgetown and Reco.

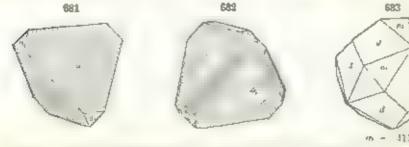
# 3. Sphalerite Group. RS. Isometric-tetraheard

Sphalerite ZaS Onoffite Hg 5-5e
Methicumabarite Hgs Co,oradoite Hg I e Massive
Tiemannite Hgse

The Smarteauti Compressions a number of sulphines, sciencies, etc. of one increase, and the degrees. These are countries left bodies in crystages ton. Nearly stars shows be smaller you define structure of the above members of the Spinismic Group.

SPHALERITE, Zone Bur you or Buryton. Bouck slown More Level False College.

Isometrie cirul-whol. At the structure similar to that of diametric of p 40, with Zn and S atoms alternately taking the position of the C



atoms. Often to etrahedrons, the positive and negative terms frequently showing differences in lumer, etching lines, etc.. Cone, doderahedron, and

tristetrahedron forms also present at times. Twins organion: iw. pl of 1111. In the ng often repea ed, somet has as polysymbetic lamence. Crystals often distorted or rounded. Contractly massive clearable, ecurse to fine granular and compact also filated, some in es hi rous and radiated or plumose, also betryouth, and other in, tauve shapes. I ryptocrystadion to amorphous, the

laster som tanes sa a powder

Cleavage disterability, highly perfect Fracture conchould. Britile G = 39-41, 4063 whate, New Jorsey Luster resmons to adamantine. Color commonly yellow, brown black also red, green to white, and when pure nearly coursess. Streak brownish to light vellow and white. Transparent to translacent Refractive index high: n = 2:370-2:428, rising with increase of iron contents. Some varieties will phosphoresce when scratched etc.

Comp. Zane sulphale, ZaS = Sulphur 33, zinc 67 = 100 Often containing iron and manganese, and some a nes coars, im, mercury and rarely and and the Ass senset has creature craces of indian, gaintin and thatainn,

may be argent ferous and auniterous.

Var. -1 Connery Containing artie or no from colories white to vellough brown somet mes green is = so il The re-, e red only or we transparent crysta, and knowledge of motories and also have to the grown flor temperature to the feeting a r the There is a marker out of the marker to " in grat, and subject, level when the higher it was where, pure a to the second of go that if he was the second of the second o

Car du la compara de la la compara de la com being on Morro or agree done much from Disserted de l'autre a

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yields a zine oxide contrag on charmal.

And they were to be from a best of some by tengen. me of a spanning to a particulation and its particular to regard as the second beautiful range

Che - he have a with man in the rest of the contract of the gin to the transfer of the transfe the part of the pa the said that a comment of the second of the said of t

the box and a second that are relative as immediately are for are for he can to a the set for one of the set o

trada o hursello. Promish Prizenn. In the speciment of the traps pour mercendu. I useas: , the literate to the start of th fr as Wear late in Die in the States at War wanted London Longe win war at An are very in Lake to ter belo has sen in In an large erange are and at the And the state of a light in the state of the state of the court of the n in season are the important are a rate and Was or Countable M. in Mille except trade and happen better to an order or the eyest area the in in the become any and to the an all the state of th Ranks product to the transfer of the second the water of protect to the protect of the protect there was a figure at the stand south in the court of the same on the section of the

Named the term on a de dies, resembing games, we'ted a real, the word in a this ages such a single

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taxar San Luts Potost, Memor.

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THE STREET OF COLUMN TO THE TOTAL COLUMN Man 1 com 1 com 1 com C and str. Note to r. No. e. Cross. 1 -ax ge 11 (-p/a-a -, - -12 a 44 La 1 Tt to on the hard the formation a Mangalance and danker or radiuse

Alaban I to - Mangaziere a no ie M. w. w. e.e. Zent at a shows a w. " ii are a perhance soft and the second the shape to the state of th sphalette and g a towar ge of ed from last purpe to the second of the harmonie of a state of an armonic of the war appearance with the

cleavage in the Brust, meteory of Alas noted in Allegan meteorities

#### PENTLANDITE.

Isometric Mussive, granular Cleavage octahedral. Fracture uneven Britis H = 3.5 + 0.0 = 5.0 Luster metallic Color light bronze-yellow Streak ight bronze-brown Opaque Normignetic

Comp. A salt hade if from and makel, (Fe, N./S. In part, 2FeS NrS =

St. phur 30 0 from 42.0, makel 22.0 = 100

Obs. Per that the commonly occurs intergreen with pyrrhotals and associated also with majority more the generalizing pyrrhotals and properties to Norwey those with the copyr to at any scalars, introduced to the more tylings, and produce the asswer tylings, and produce the asswer tylings with pyrchotals in the factor of history tylings. It can be distinguished from the auter by its cleavage.

## 4. Rhombohedral or Hexagonul Group

Cinnabar	HgS	Rhombohedral-Traperobedral	t 1453	
Greenockite Wurtzite	c ds ZnS	Hexagonal Hernmorphic	c ( 8,09 or 0:6175	e 0-9364 0-9440
Millerite	NiS	Athomisohedra!		0.9883
Niccolite Bresthauptite	N As N Sb NuSb.As)	Hexagonal <sup>9</sup>	0 8194 0 8586	0 9462 0 9915
Pyrrhotite Troilite Covellite	Fe Su, etc FeS CuS	Hexagonsi	0.8701 1.1460	1.0047

The fourth group among the monosulphules includes several subdivisions, as shown in the scheme above, and the relations of the species are not in all cases perfectly court. It is to be a steptic that the supplicities of mercury and zinc, already represented in the sphinerite group, appear here again. A ray study has revealed new relationships between these in acrais but has not yet clearly defined the whole group. Covellite has been allows to have a structure similar to pyrris the although its axial ratio of the series structure from inflarite and show telescopic and breathoughtte differ in their structure from inflarite and show telescopic and breathoughtte differ in their structure from inflarite and show telescopic and breathoughtte from that given above, but usually fully in being a multiple or sample fraction of that opened. The former yaques are retained in order to show that whatever infer air ties exist in the relations between the numbers of the group they do have striking crystalingraphic characters in common.

If we are greatest by (artif), the promount parameter of warts to, great on to the range press to 4 the serious states at z=1152, where it 1011, then the various of a 1 the serious of and and and are obtained which correspond to an interest of these species, between a control of the species, between a control of the species, between a control of the species, and the species of the species of

#### CIRNABAR.

Rhombohedral-trapezohedral Axis c = 1 1453 The atomic structure se given by X-ray study gives double this value for a

Crystals usually chombohedral or thick tabular in habit, carely showing trapezohedral faces un rhombonedra, penetration twins also accular prismatte. As in quarta, crystals may show a right- or left bar, led development and turn the plane of polarized light. In drystathne merustations, granular,

massive sometimes as an earthy coating

Cleavage m 1010) perfect Fracture subconchoidal, uneven Somewhat seen e H = 2.25 (i = 3.0.8.2) Lister adamantine inclining to nature which dark-coursed and to can a fraille care as ( a recommendred, of on minuting to brownish red and lead-gray Streak scarlet. Transpare t to opaque Opticana + High nices of refraction and strong barefringence | \alpha = 2.91, \( \ext{e} = 3.27 \) St. we strong circular polarization, being about biseen times as strong as that exhibited by quartz. See Art 402.

Var I fortunes either a cast direct to some or granular ep ped to, or compart triple red to reduce to the control of the car of a he of brewn come, with somewhere a ter wouds stream occasionals main in structure though commonly granular or compact

Comp. Mercuric su phode. HgS = Sulphur 13 S. mercury 80 2 = 100 Usuals impacts from the aim attace of casy con oxide, breather

Pyr in he cases take against ack a harrier of mercuric suipho e to with soch on the on the trade of the state of the state of the great the great the state of from at that or mercury his his above it but be a less to the elst made of the

have like to their advation of a latter of their above for the first gar a conducted.

Diff therefore peoply and rated with an except the grant conducted, for we can be given by any section as a record to the configuration of the configurat

the times the Treatment of the interest of

Artel or a nut to prove a ser at the at the talk in a satisfic and helitepier to get out to the and of the to work on the best of a timer or to part formed to the timer of timer of the timer of timer of the timer of timer o out other to govern cables at a time and a property want on an interest design as because the second of the many proposed of the device of the second of the s many to be as phase and a scarce does transfer and a second matter to a concentrated TRIVERS & STORES

Obs. Canabag as the only common mineral of mercun and with rare projections comend des the control of a control le e to a verifica e value have control on a servicion to legal to legal to a control of a to a to a control of a c which all properties the same of the same of the and the transmission of the metal as were evaluated to exercise g a vigile of figure rise now to be une site of it me and now outer the politicism of our residence of our residence of our residence of the residence of the residence of the residence of the rise of the residence of the rise of the residence of the rise of

there are was an in a center gration of the Bakhtan' toutest a the terminalay, an engine trains but a same to a me to a me to a man to the but a man or of a mention of the same the grant, a mention of the same the grant, a mention of the same the same the grant, a mention of the same the Horovice in Boltenia. It occurs in good crystae a Mischeslampinery in the amatinate.

theraces In portant deposits are at the anti-condition properly in Carmola, Austria) I have the also I am near term to the term to the courty. The court of water's there we be used to be the best to be and the service of the service of the proof with the rest of the service and a sure of the tensor different and the man tensor to the man tensor to the control of the set of the control of the contro the line over lase Napa Santa Care New Yare or and See Head New Mea. The tenters, has a tree thereon is the arms of earlier waters which may deposited be The state of the second to at the use year local to Novada, I and Oregon, and at Technique, Brewster Co.,

so one of autor past, weed to come for a latta, where it is applied to the red resp., arms a month the next time at an absence or an arrest comment to appear or to all the a proper or the rate bulby of the and mercan is to be graphed to the conf, a shoots we are was every new for and horse a chanatur, and my got at last the spanie.

the growing a few matters have may set the injurery to quantity

Use. - The most important ore of moreury

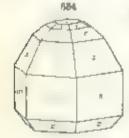
#### GREENOCKETE

Hexagonal-Lemmorphic Karea in hemiotorphic crystals, also as a conting

Cavage a 1120 district, child to reperfect. Exactore concordal

Brittle. H = 3-3.5. G = 4.9 54. I gater administrate to resmous. Caller heney- c ron-, or crange-velow Streak between cringe-yellow and br leved Nearly transparent Optically +.  $\omega = 2.508$ ,  $\varepsilon = 2.529$ 

Comp. C wan an e tiph.de, CdS = Sulphur 22-3, cadmium 77:7 = 100



An art will here 3 in the base open shown to fin on a structure s are a this completence

Are recording to a read a court and absorbed water that or to up a him cost up in aphase to line seen that oil zamaho-

they and turn assumes a community or or Pyr etc while one the true is the area and remove the ming. He is option these groups of a recision and all and a salest terms to be

with white, given in R.F. is restrictly town making. Some ar in hypertelepoor and affinding

hydrigen size to be her prepared artificially in several many. Proof inted each mer malphase after fairly with a same carbonic or a did sand and greene kut

Che a come seed on proper when on the set of the best of the set o Has non-house to solve the section of a common profit of the section of the secti permitted by ter Para and the time to person to an a in terms a d Franch Very I may be bree some a form a man at any action a Mis-Popular Major Car Car Prica Not into turn take furnace product

Warry to. - Zino no., who Zan ple aid write his to hereamorphic hexagon a crys aid graphics of the final training of the material training the age so the the rare from of star suppliede. It is stalled at tempera tree above 1720° C. For he is thought agil sterile see under the after price bound of the Roberton at the or h Bus Spice Bire ma, or crystale from the same times a patient, Bureau at times in large tacular crystals from the spanish near Castro Arrevola, Peru. In the I noted states in fine way and reserve form it site Montaha, in crystale

In a Joseph Mase of an in registra Bone of the Behenda.
The mass of thems of the second of the second works of a phasence and works to a at Tram Beherma Lakenid,

## MILLERITE. Capaziary frontes

Re-misohetral Lam v a ver, spender to capillary crystals often an describe radiating groups some time I to a new the swap of and has in condition tuited on the party some or ar an enderted. I is chambalasaren could be a gooding mane and art read twins may be corned. A-say Bellevi who was that the aft to be a not an ir regular it is

Centrage period p runtin 1911 and 1112 Freduct a strip Britle, capitary or an east of H = 3 , G = 5 3 or h lister motivate Copy brais-vehior invaring to printe-year a with often a gray printegent

tarnish Stress greet ist fock

Comp. Ni ke, supta to NS = Sulphur 35/3 nickel 64 7 = 100

Pyra etc. In the men of the start proper uses. Bill on chances, there to a guidance When making a term is a first to a subject to the law only.

Enter the fine one are not as the term is the base of the terminal and one given a come motals are go that the various and trace do the and min enter he Guice, cates in

Artif rous of the chare form the aginfacially by treating under products a

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Obs. If one contract to a terrest the a present one at a the there will industry at it is a see use of the store sometime to be agree the constant to the contract of the constant between the constant of the const

the rest of the color of the second of the s take a growley of distribute of en price in the first price of the first as the reset less it was are. If we have We can be given chromolerous garnet is when to work, Quality and the Son or district beauty.

Use In one for are

Becamenty Art somewise by with somewhere to gravity 47 and a ght defleres to in some fineparent content as the section of paramorphisms rom or rathle

Vo and very rarely at Oher ahr near A real-renes. I mandand

## HICCOLITE. Comme Nucker

Hexagonal Crystals rate A-ray studies of the structure of n evolite and prosthauptite show because hal syn metry with elses report take perbe, wreng the two. I shally massive structure rearly impolpance, also reniform, conumpar, reportated appresent. Francisc meyen. Brille. H = 5-55 G = 743 7 of Laster nature Color pale copper and Streak pale brownish bank Operate

Comp. - Nickes arserule, N As - Arseruc 56 l, nickel 43:0 = 100 Usually contains a little in a and cobast also so phur some were part of the arrence is replaced by antimony and then it grades toward oreithroughte

The intermediate various have been cased order

Pre, etc. In the cames t he on interme services given a facil archimete of gramme. In the open tube a supposite of argenic are note, with a trace of supplianting funies, the assay becoming veilowish green. On charcist gives arecard finite and fuses to a giologic, which the ter with a rux glace, afterior In surpressive exidated, tractions up exist or all an name, the art mound arreties give also reactions for antimony. So also us a ma-

PERSONAL PROPERTY.

Obs. Note that a namena seven seed with an abite, chlumbing, annalogues with matrixe sharp and the source assent marger in prince obtainings me and other sould not practize I de cur I alma a religio per relación de mente lacidade lacida tone at a second a result of the first of Thorago, to make star, in Heisen-Les In a es that Voc t have an at the re of tratar for Borne Buses. he to act out a the a first up a cobalt once at Cobalt and in haver leset, Thunder Bay. At Mr. Arma

Use. - An ore of nickel

Takens yer. They ber as her group nontion No. by has been shown to be a nan-ture of an en as obasis. From Elk Lake, in the Bre than pite. Notes as the state, No. 3. Receive hexagonal execution country.

same affectively were the . - A total properties first than the to a gr ! . . . r D of x . . re-re ! . I at Andrewsberg, in the Hark Mta, at Mte. har a local harried as any considere of Same a. At a last Ourgray

## PYRRHOTITE. Magnetic Pyrites.

Hexagonal.  $\phi = 0.8701$ .

- 45° 8° re, 9901 ∧ 10T) = 76° 0° ck, 0001 A 4011

Twins (w of (1011), with vertical axes nearly at right angles. Fig. 441 p. 189 Danger en stals were, commons about also recogning tal with faces streated between ally distriby massive, 685

with granular structure.



Parting cotton, semetip exchanged. Friedure and even to subcomb uday. Brottle: H = 3.5 + 5. G = 4 at 4 tel Luster me also Cour be ween brenzeye has and a pare nec, an a sulpart to opend, tapage. S rock dark gray she lack. Mignetic, but varying

HINCH OR HITCHOOP'S SOME HITS PRESENT IN THE PARTY.

Comp. I cree is a uphide constructed warrable am ania of desalved support In set there prorection the maximum of excession, tur na ic the be commed a a few come Analysis shows a far on the feet to best the in a second are nicked one probably to etablish grant of period the Fish = Support 30 6, arc 1 50 4 = 100. (1 Art 485 p 354)

In all the different from the time is a unit only more or less time and their will be ter a la responsación abore there de altra esta en se fina forta bir pare

construction godings

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Diff. Disconguished by the sendor me inches order color, a so by the magnetic process

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The Probate sers to each boxe is a sea pres with boxe give in week with an given there is an a great may at them which it has been seen regated by some form or a say with affirm that the formore y more ated with that

converte, persit persit and to immenest tell state. It is also found in emetacis metaphorpical deliments, to your denime a n longer of an illustration a design mercure of less to an Atto see from I in a common plant over more with garrier that the line is a see created groupe at Post to Passent I are a tracers at the year at making a I relangulary However, the Property of the P there to the me or of the control but at a two control of the control but a superior for a superior to the control of the cont Tennessee Ver any trace a deprendence partheaut course a halfary, thitago In or as in from the Justines intant

NAMED OF BUILDINGS ASSESSED ASSESSED.

the entire their utes of entering about the other was a fact with the sal se, extent come or me and an are degradate less no a harter o. Chattering, cortheast of Cosmol Common massive form in serpertune with magnetice.

#### COVELLITE.

Hexagena. Year study shows a complicated stricture so at to that of pyrrbatte. The axia ratio well see table, of our bar at the two queerals have often been an med together. Caynoon and not that hexagoral

plates. Often massive.

Cleavage has perfect France in the lamine H = 15.2 G = 4.6 last restance it relations that a best he ar larger Sound Ince our a purple time. Out , shows fire an , replay where produce a with water Stock end gray a brack. Opacite In our thin places to asfucer has show possible on a refragrance at the elle + as a 45 mile Comp. 1.11 stable to 18 = 5 apart \$3 6 corper 56 4 = 190

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Artist a survey of a survey for the first of a compact they program with a rest and a second and make a lit country graphs or to on a most specify a per-

mis plante.

Obj. I are to me express a supplier trains seem and engineer by we be the heavened who train City have a set by a set in the get are set out the get of the getter and the get Emp Frances of a compact to produce the second section of the section of

High the state of Justi to I tan At Kennecott, tusks.

Het entremerre. Described a N Ross S had above by thi reaccipe term to be a prior are discountries as a cost of the Literature of the contain. H = 5, 4, = 6.4 Coper ight brance reason from Hadan & O. Neg, Hadacond, dermany

### C. Intermediate Division

The following species are sometimes regarded as Sulpho-salts, namely, Sulpho-termies, etc.

BORNITE. Peaced Ore. Purels Copper Om. Varietied Copper Ore. Embescite.

bemarine Habit cubic faces due cough or curved Twins tw pl. offit free per retion-tweet ("retain rare. Latate massave, structure granular or compact

t neavige . I in traces. Fructure small conchantal uneven Brode R = 3 (, = 4 + 1 moter an and ( mer between interested and bin liberk from in tresh fructure specific in bescent from normal. Streak polygray shib ack that be

Comp. A stephant of copper and non Custies. Copper 633, iron

11 1, mappingr 25:0 = 100

The a nerse often continue small amounts of chalcourte, etc. and therefore shows conis or the last to the percentage composition giving than 50 to 70 per cent of copper ate a like a per total attoria

Per etc. ... car conect to de gives a faint enthante ut subptur. In the open take yes an interest need for one come and or to be a common magnetic groups He I was promit to the celerate and for a copper and with male A THE STORY OF ME IS THE THE PARTY OF A PERSON OF PARTY A

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fraction and a start of terrate B there are a much distributed by the first of the following and the sale of the first of

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hand after he remember Ignative via them 1745-1791

Use - An are do not be at least two probably terrahedral Managere H. # 4

Germanite. - t Cr. \* \* Leonotric, probably terrahedral Managere H. # 4

G = 1 10-4 50 Court outs revisibly grant Method for I taken intergrown with course to provide site at Issue outs from the house the provide site at Issue outs from the house the provide site at Issue outs from the house the provide site at Issue outs from the house the provide site at Issue outs from the house the house the provide site at Issue outs from the house th

Linearies. Instructor A a total I a a total and common to the specific of the second and the property of the second and the property of the second and the s the last store parties in the War of the above to in sugger buttle. Whatthe man we have the man and the property of the state of the contract of the state Lacking factors of Marchard Lackbook with the art and the fibritists of which to the fibritists of which the tenth of the control of the fibritists of the control of the c octabedrons from the riegen district West, thront to probately ack a variety of honory c.

Violaritie. — A nockel suiplie or Comp given either as NIS, and then assumed to have some structure as actif companied which has been shown to belong to Part of the processor products on N to N, and how we require group will another Perfect to a close age that a rest gray flar area regions as a cape to hand with particle chalcoper to act per tribe a the heat West same, thank to Newman, as a measurement of pentian because the a structure of the structure of pentian because the analysis of the structure of the st

Polydymine. Named a firm to \$50 In octahedra, creately free on the twinned street as as as as and of it in to \$50 = 4.54.4.81. Copyrights. From the tracessar structure, more, another set of Schottbury and southern of Wisser in the Sieg, River dand. The join of the reported from the transfer that the total on a first distinction. It has been started to be a fact ture of one quitte as a violante, but this conclusion has been

changing text

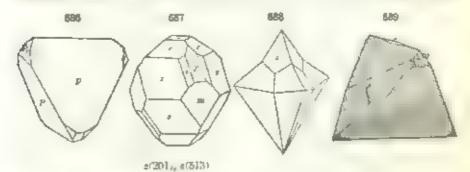
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### CHALCOPYRITE. Copper Pyrites. Yellow Copper Ore.

Tetragonal-sphenoidal. Axis c = 0.98525

no . 111 ∧ HT = 105° 40

Crystals commonly tetrahedral in aspect, the splish idal faces p[111] large did by exchanged p. 111 small and tradlant. Some ones both forms equally developed, and then octahedra, in torm. Twins (1) tw pr. p(all,,



resembning spinel-twins (Fig. 443, p. 188), sometimes repeated as a fiveling (Fig. 688, 2 Tw. pl. and comp-face c(101) (Fig. 689) often in repeated twins 3 Tw. p. in 110), tw. ax s.c. complementary penetration twins A-ray applyes shows that the structure is similar to that of sphaleries, be layers of zine atoms in that material being replaced by a terrare agers of corper and from atoms. Often massive compact, so nettines botty a tal or replican

Cleavage 2(201), somotimes distinct. Fructure upoven. Brittle. H = 3.5-4 G = 4.1-4.3. Laster metalar Calor brass-yellow, often tar-

united or in learner t. Streak greenal black. Opacite

Comp. A supplied of copper and tron, Culies, = Supplier 35-0, copper 34 5, trop 30 5 = 100 Analyses often show variations from this formula, often due to mechanical admixture of pyrite.

Sometiment a m arger televisias, also emplaines mares of recent in an I thin its decreptates, e g AND THE RESERVED AND ADDRESS OF THE PARTY NAMED IN 2 --ed fire a map ha tir artificially prepared () As d I was parite and or get for it is in the first house its at an experience in neral reaching comper-A. . HAST ALSEto the first the same beganning with a de pion many family of 11 - I--FREE F H A ST L 1 1 to aft disportion according

The most bepostant ope of engage

## D Disulphides, Diamenides, etc.

The healt are dispersion of employee that it is got spec. The press. It so to so to the control of the entrol of t

# Pyrite Group. RS, RAs, RSb, Isometric-pyritehedral or -tetartohedral

Pyratohedral		T	etartobedral
Pyrite	108-	Cobaltite	CoAs8
Bravoite	the Ni S <sub>2</sub>	Gersdorffite	N1 A48
Cobalmickelpyrite	(Co, N., Fe S.	Ulmannite	Naus
Hauerite	$MnS_t$	_	-
Arsenoferrite	FeAs <sub>t</sub>	Laurate	Ru%
Sperrylite	PtAn	Smaltite	CoAss, also (Co Nt) Asi
		Chloanthite	NiAs, also Ni,ColAs
		Skutterudite	CeAs

# Marcasite Group. RS1, RAS2, etc. Orthorhombic

		Д	6 0		110 \ (I)	101 ^ T01
Marcasite	$FeS_{c}$	0.7682	1:3	1 2342	74° 55′	116° 20'
Lollingite	FeAs	0.6689	1	1 233 [	67° 33°	123° 3′
Saffiorite	t o A.sa					
Remmelsberg					245 4414	1007 101
Arsenopyrite	FeS, FeAs		1.	1883	68° 13'	120" 58"
Danaite	(Fe,Co)S <sub>3</sub> (Fe,Co)A <sub>2</sub>			035	ana nat	LIES ITT
Glaucodot	(Co.Fr.S. In.Fe)Ass	0.0042	1 ,	1 1925	65.3%	118, 79,
Wolfachite	Nus, Nu As, Stole					

The Practic Group includes, besides, the compounds of the Co, Ni, also others of the related metals. Mit and Pt. The crystalization is isometric-pyritohedral. X-ray armitists allows clearly the same structure for pyrite, sperrylate, coballite, geredorffite and alloundate, the last three, however showing te artchedral symmetry. Smallite-chosin late, and aratteristic the last probability pyritalists pyrite edial and casely related to each other do show

strue wal differences from pyrite

The species of the Marcastra Group crystolage in the orthorhombic system with presents angles of about 70° and 1.0° and a prominent macrodome of about 60° and 1.20°. Hence fivefold and stailed repeated twins are continuously several species, in the operase the prism and in the other the macrodome maned being the twinning plane. X-riv analysis shows closely related structures for the members of this group, billiague, sufficient and numinalsbergite have abortion structures as a so have arseropyrite and glangedom. Further the arriphture is coosely related both to isometric and tetragonal (rutile) structures.

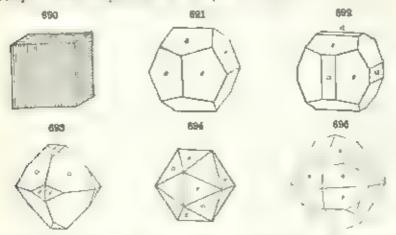
## Pyrite Group

## PYRITE. Iron Pyrites.

Isometric-pyritohedral. Cube and ayritchedron c(210) the common forms, the frees of both often with structure edge a 100 c(210) due to oscillatory combination of these forms on tending to produce rounded faces, pyritohedral faces also structed 1 to this case of aheadon also combinate. See Figs. 600-605, also Figs. 151-150 pp. 81-82. Twins tw. pl. = (110) and tw. ax normal to this face, usually penetration-twins. Fig. 433, p. 187), rarely contact-twins. For illustration of atomic structure see p. 41. Finquently massive, fine granular, sometunes subfibrous radiated, reinform, globular, stalactics.

Cleavage a(100,, o.111), in fastmet. Fracture conchendal to moven, Brittle, H = 6.65 G = 1.95-5.10, 4.967 Fraversella 5.027 Libn. Luster metallic, splendent to glistening. Color a pase trees yellow, nearly uniform Strenk greenish brok or brownish black Opaque

Comp. - Iron dandphase FeS. = Susphur 53 4, from 46 6 = 100



Medal, colout and deal arm and also copper in small quartities sametimes remove and of the put of opening man, a real open in some construction of the party of the put of the party go a freezer is take a present of a complete that or about fine for the real firm is Value 1/2 per rent As. A collect dere o perite rote base. Sweeze has not amind

Pyr., etc. - Facily fusible, (24-3). Been as any etc on heating and a sign a tiphic distance there are then a said of the accompanion by the property

the our agid. The near secret and a level, a shie manage and need

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#### COMALTITE

Is in the treat to trad at commonly in cubes, or pyritohedrons, or comline as rescaleing continuous forms of pyrite. Also granular in assive to compact.

The construction of property of the construction of the constructi

Charage entry to be perfect. From are moven. Britis: 11 = 5.5. (a) to b. I be a routed of Construction and to perfect with the continuing much then between an block when continuing much then between a struck as the back.

Comp is planted of cobalt CoAss or Cost to Ass = Sulphar 19.3, argenic 45:2, cobast 35:5 = 100.

tion present a residence a communication or organization as

Pyr ste to the to the transfer of the gent to grow as the real present to the transfer of the present to the present t

Obe Star I can't be imported by some fine to que to men and the star of the st

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U mannete s a morable in consideration of the consi

VILLAMANTATION. Supplied of Cu.Nt with annalyr amounts of Co. to Microscopic study indicates that the a texture 11 = 45 to = 44.45 four front black 10 de-reg dar groups of a bosocialism of crystale and to reducing nonlinear masses. In dolumbe from fare thee lourn't near I tamed in Lorin. Symit-

We have Described as a don-took sulphide-antimonide from Broken Hill,

New Yough Water, this been shown to be a matter

ha mitte Dosen eet as a meke an met basmach as plade from near Schingston

and some farmance is calconed by maneral graph and a to be a contrare

Laurite Suptains on he im and some or man essent a Rary in months octahedrones on grants. Octahedral consumpt in 7 G. 6 50 another metal of Care tark purposed by the plateau makings of Jorney. Also reported from Cotombas an Luregon

#### SMALTITE-CHLOANTHITE.

Isometric pyritahetral X-ray study shows that smaltite-chloanthite an I samperadate have somilar atomic structures but show inferences from the pyrite structure. Commonly massive, in reticulated and other unitative ebunes.

Cleavage indistinct Fracture granular and meven Brittle H = 55-6. G = 57.68 Luster metal.e. Cour tin white including, when massive, to steel-gray, sometimes indescent, or grayish from tartish. Streak

gravish black. Opaque.

Comp. SMALTITE IS essentially cobalt amenide. Chroantelte is nickel. arsenide. Analyses show considerable variations, RAss, representing most nearly the composition.

Consilt and thekel are usually both present and thus these two species graduate into each other and no sharp to can be from stoom them. Indo a not present in any ing around the unjust of throat to can making much true has over order descharate for the model of the new trees in the new mentals are also as a present in the new miles and another than the standard of the case of examples of the standard of th possibled a personant has produced a source of the earlier over the grant of this beets suggested has Il as, Ilalia, and I began all resent. Materia, known as kewern, gate as a that is demantity agreed to and owners of

Mr. Oh, how ear is estimately according to the high specific gravity to being to the

tirther of the Sterling and british

Pvr , etc. It the count take gives a sublimate of metable armonic in the open take a where on more of account meaning and occupitates there of such a more for B.3. or control good a real ag of hoph, the arserva where and frame to a glot or which, treated with at reserve partiages of burning one off or himself at many collabour, parked.

Obs to at a greater to your new against gether a man to colla ten la cage trequently with one of a ver and one or with a country as a point a with about of court and but we arrange a material was the pare of the original probability queumstable and repost

tion or must be seen seen between 985°C, and 450°C and 450°C because at Joneto, retail for a property or a tensor ated variety contested in calere at Isomna Debutter seed on only With a series I at at occlore, takeberg breasons of Santa en weight to the coppier of six in it. It assured on blue en Phones Santa to nour Laborate series for the state of the copy of the control series series as the santa for the series of the control series of the control of th of y we to street white and secret we with ance a Bare at I'm ale, I w lersey to cristaes from come less or around in the Cobalt district, Cousing township, Organo, Use three of obout and sevent

Sautterudite. Challamen is Codas Institution part inedeal Accommense grains on the 10 march 1 = 6. In a f 5.59 of the between the white ar I have emberny found at Scattered year Morium Buskerne Norway From Crote 6 On several, a Turtheapp In Vinna Switzerant From Franking, Sew Jones to Crack to New Ment a Fron the count in roll Options

NEW TRANSPORT THE NACO, For Ass. Massive, granular Color gray From near

Silver City New Mexico.

BIAMETO-SMALTETE Co As.B . A say broad to containing biamuth. Color tipwhite G. = will. Zachorma, near Schneeberg, Saxon y

## Marcosite Group

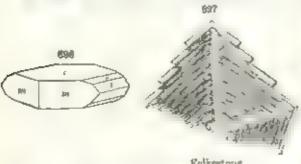
For the list of species and their relations, see p. 433.

MARCASITE. White cron pyrites.

Orthorhombie. Axes a - b - c = 0.7682 - 1 - 1.2342

eem\*\*\*, 110 A 1T0 = 74\* 68\*. R', 011 ∧ 0I1 = 101° 59° 13) 7 101 = 116 20  $\alpha = 001 ^{\circ} - 111 = -03^{\circ} 49$ 

Twins tw pl. m(110), somet mes in stellate fivelings. Fig. 462, p. 191, cf. Fig. 697, also two pl. eq. 1010, less commune, the crystals crossing at angles



Polkertone

of rearly 60° f'ostage commonly tabular c,001), also pyramida the brachysaction attracted raige δρφ30 - cr001 -Often massive. recharge filrotis in staint, tes: also glo in lar, ren form, and other mitative shapes.

Cleavage me110, pour; {(UII) in traces. Frankreimeten Brit-

tle H. = 6-6.5. G = 4.85.4.90 I ister metalic tol t page bronzeve low, deepening on exposure Streak gray up or provoush block. One, up Comp. In a disarrale se pyrite, and = Supher 53 4, non 46 6 = 100). Arsonio is sometimes present in smal singuit

Ver - The varieties anneed Japane mainly on state of crystalization. Radiated Cockwood! Part a Aggregate, and distance two restals acres like this Amor Parts I've receive alle with come or not stay as a attle also the head of a spear to one for 6.5%. Capillary to experience erestamentance

Pyr., etc. - Like parter Avera in the for deviational to contract thing synthe-

Diff I care they are a d time a sewer open to grave a me to ever when fresh teg after treat in the hand a pider when greater and could taringuished by the forms.

More su jest to turned and and lesus post in thus synte-

Marcanite can be distinguished the on a core to the following southerns. When to the region a are first and lacred as a rated a his a learning or the second residence in a the rate and to er after vaporers are a time consoit. It was not it will be found that a the more of printer the greater part of the salps and some and mischen and man hagen the second of th emired in a fine state. The stokes method which can be used you that one to intermine the name to if he two o new a consistence is so to spon the difference in the metabolic wife and a stan or loads from a cross so place. In this case of parties about 5, per certail the a pit the manner of the site whate will catenate the name ? percent is earliers. At other our last consists to had githe a narra a to a per our satisface of Ag N to wren mur mate will be turn ashed I in interces brown, copar, then cad and finants libre-Wheever perste becomes unb wight to his will ab-

At Marmonte being to a colverment in meaning aftered. Sper menu often distinterrate with the formation of ferror is authante and adapture need. It also alters to prove,

Tipe de etc

Marcasite is a p. of. son stable compound than pyrite and a formed under emaparatively and elementations. I approximate have she en that it is dependen as temper-

at ten limit width to again from a time one. The higher the recoveratings of deposits in History for where it is a first or many on their names of the not the following of the second of the

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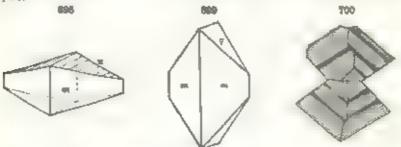
Resistanting a see . . Ir. a br 7 - 2 - 4 - ye Proce Compare a part of the Marian In

## ARSENOPYRITE, or MISTOREL.

Orthopher has been a sea ob 73 1 11882 Year plans almost that he had early him for the second of the sales father charged that the lemeth of a should be an acc.

> restriff, \$10 \triangle \$10 - 68\* 13'. 03 4 1,5 44 10 014 A 014 = 334 6% netif p 812 A OTO - MYSTOR 1009 4 011 A 011 - 99° 50'. 00%

Twins' tw pl m(110), sometimes repeated like marcante (Figs. 700 and 463, p. 191), c(101, cruciform twins, also trillings , Figs. 458, 459, p. 191). Crystals presente m(110) or flattened vertically by the oscidatory combination of brachydomes. Also columnar, straight, and divergent, granular, or compact.



Cleavage in 110 rather distinct c 001) in faint traces. Fracture uneven Britile H = 5:5-6. G = 5:9-6.2 Laster metallic Color silver white, including to steel-gray. Streak dark graviso black. Opaque

Comp. Sulpharsenide of iron, FeAss or FeS. FeAs. = Assence to 0, sulphur 19.7 iron 34.4 = 100. Part of the iron is sometimes replaced by cobalt, as it, the variety dangle (3 to 9 per cent Co).

Pyr, etc. In the chosed take may give at first a little yellow a label of arsenic and then a completation and one of metadic arrests, which is if the gray create a one to be extend on the late to black admittable a teponal lattice and it that per take gives after the per take gives and a per take gives after the per take gives and a per take gives after the per take gives after the per take gives and the per take gives after the per take gives and the per take gives after the per take gives a per take gives and the per take gives a per take gives after the per take gives and the per take gives a per take gives after the per take gives after the per take gives a per take gives a per take gives and gives a per take gives and gives a per take gives a per take gives and gives a per take gives a per take gives and gives a per take gives and gives a per take gives and gives a per take gives a per take gives and gives a per take gives and gives a per take gives and gives a per take gi

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Guidamentite Festes Orthorhombin at the ent 120 1 11568 Creatule riche gate by a set of the force in 150 set or white the street gate 11 to the come in a set of ore asset of a west lead and some some of the fact that the sear being burger of angeloof the processor in a real content and the set of the set being burger.

Congodot to processor in a real-man and true. In this lip arthorhom the restant

sten so , p 430 the transport of a 5 c = 5 90 4 21 Inster actaly copie

gravish tin-white - Decurs commonly with other cobalt minerals, particularly with coba tite, with which it is often a tergrown. Also associated with himself often pyrithelite, gazena, parts etc. For i in the restale, often wans, at finkanole Vastmanuer I, Sweden From Sk Aten I near Malain Buskers I, Norway From sear Blasse America, Chie-Reported from Creat to Corgon Found to the olver rems of chalt Unitario The mainte of Francoina, New Hampehire, appropriete glautoidat in con pes tinn. Attorniolo, which appears to be a mosture of gui row it with some other in acral, occurs at Oravicta, Romania Named from ylegons, blue because used for making smalt

Concerning the tage, Orthorhombic to minute and creases grants found that tracture Color steel-gray H = 4.55 G : 9 from oute ferms norther in the master sing limiter. Frankean, and from dunitional Ly tento by senior south Africa.

Wolfschile. In tast t he test S near convente. In small crys are resent any armsapprove and columns remated H - 4 5 to = 63/2. Color adver-white to taswhite From Wolfach, on the hantig, Basten, Germany

Melonity -- A model telluride No.Leg. One perfect elements. In indistinct granular and I desired partie on A of a resultsh white, with metallic later A = AReported from Magnuss. Bender to Copyright Originally from Metalian or or, and also from Stanishing many valvenes to Caulorous. Found at Worterpa, New Youth Wales.

The following species are teliurides of gold, silver, etc.

SYLVANITE. Graphic Tellurium.

Monoclinic  $a \cdot b = 1.0339 \cdot 1.11265$ , b = 99°35′ Twins' tw. p or 110) giving rise to branching arborescent forms resembling written characters, also bladed and imperfectly columnar to granular

Genvage 5 010 perject Fracture uneven Britis H = 15-2 G. = 7983 Las et me m.c. bn unt Color and streak pure steel-gray

to silver-white, inclining to velow

Comp. It hards of gold and saver (Au, Ag) Te, with Au Ag + 1 1, Traunam 62 I, gold 24 5, silver 13 4 > 100.

When a alt e of the powdern mineral is heated a concentrated sulphane in the restriction a set me or an appears to be a committee to a state or a management of the set o the transfer of the flame after long to wright a cities made the metallic globalic is we that will a word or and appropriate of selection by the fire a weight as with which

Obs. Systemate sours a verse more abs with not ve gold, a her gold and in ver telturn ex more and such a street of a tractic with partie not after all as a with a street on a filter of the arms of the contraction of the contrac per a trans a transportation after act or rist but a built and the deputy a better to a the me we call the firm of the made of the program of different and the fig. he At high man. When there is a fact a conto the second magnific for a get one of the the age for each marker of the Member of the Secret to the Control of the Control is to men men a reason and attention hand, and in all action to the amount one of the person of the required or the total termination

Ar are galo Use Kreanerite 1 s de il gold cold silver 'Au Ag Te, like celvanate la pramious reserved effections as the reserved to the same of the perfor \$1 - 25 1 -But the water to a bear with a River that wite aster I are guarant ments of we arence have a bout etc. From Singy Ag in Frankylvania, it man a an a repute

Converge I go o store to be with small amounts of sever the drow in some all sath-supped crystals strated parallel to their length. Massive granular to crystaling. B = 25. □ = 9.043. Color miles white will often a land vellow times. Tests similar. to those for sy visite a that a serious the serialism of the entires but in Aurice and Colorado becomes given estant source of gold tower at an and occurrence the same the same of the first transfer of the first testing at the appropriate the formal leading to the first testing and the first testing and the formal leading to the first testing and the first testing testing to the first testing testing to the first testing testing to the first testing testing testing to the first testing tes 

Muthanannie by to the a storystale usual a singular in one firection the part - energy are a political of the property with Age two in fan dees being in the artists bothers record and a month property a we Handers to the transfer of the transfer of the transfer to the transfer to the transfer of the transfer of

Bagyaget has he can also as go some analyse show also about ? we that I have grant at once a gradual in the period of the first and an action of the first and action of the first action brone Sugg-Ag, and Orleananya, crame same, Kon tons. Reported train colorado and Invaria Creek, New Zealand,

## Oxyanlphides

Here are included Kermesate, SlassO, and Voltate ZngS,O

Remosale Principle to to make once ander stone or other forther there are respective to the entire to the entire the entire the area to the entirect. II = 1 5 ( = 45 4 ] Lateral among as the referry and in

Remonders a secretaria and a secretaria and a secretaria and the secre With the Opening and concentration of the world to the configuration of the contraction o Park to New he asker & not a the West over on a stantion, Hands Co., No a booten, Names from herea, it and a given at the lors querous eringment to the other

there per to the number of the transfer of the transfer of the witness of the transfer of the Voltate - Jun and he he I style to 47 to 2 to 12 he manufact a plant to good his H will 4.5 G m. or he is they are real we will he had been account. toggo common y again and with our a top in order or mother or from man Just chart in the late of the country of near Pontgiband, Lay-de Dane, France Reported from Leiber Report Lune.

### III. SULPHO-SALTS

Sulpharsenites, Sulphantimonites, Sulphobismuthites.

II. Sulpharsenates, etc.

III. Sulphostamates, etc.

## Sulpharsenites, Sulphantimonites, etc.

In these sulpho-salts, as further expanied on p. 349 sulphor takes the place of the oxygen in the commencer and better understood way gen act is one various acid H O sulphum and Rest, phospione and B.Pot, etc.

The species delided are salts if he at the olds if they but granter antimony and bismuth. The most important acids are the orthogenda. HiAsS, etc., and the meta-acids, HiAsS, etc.; but HiAsS, etc., and a sense f others are included. The metals present as bases are cleefly copper, silver, lend also rene mercany win, runes o arm, so mokel, could in sincil an on-In view of the hypothetical character of many of the unds whose sales are here represented, there is a certain advantage, for the sace of comparison, in writing the composition after he dualistic with id, RS Ass. 2005 Ass. etc.

blany of the species of the anglo-salt group are care and can be only briefly month ned. Further as many of them are maintedy associated with . ther similar materials and are frequently imperfect very stall sect good analyses are firer rare. Therefore the interpretation of the available data and the proper classification of many species present difficulties. For quately sover if general a rules of the group trive been made receive, and these temperary those in the by Wherry and Fosting and by Cesare chave been largely followed in the classification given below

It should be turther nexts and that many authors include as part of the elight out group many of the species consider in this took as be origing to the intermediate dayson of the suphicus, interpreting hist composition as

sulpho-ferrites etc. see pp. 430-452.

# A. Acidic Division RS : (As,Sb BL<sub>2</sub>S<sub>1</sub> = 1, 3, 1-2, 2-3, 3-4, 4:5)

E chbergite Vrhane That I As Shasi Livingstonite Hgs 250,50 H.strinte 50 above 284 857 Bush

(Cu. Feb.S 3(B), Sb), Sc. Chiviante PLS 2B), Scot 2PbS 3B), Sci Gladite 2P S Clas 5Biss Rezbanyite 3Phs Cust 5BigSt

## B. Meta- Division RS (As, Sb, Ro, S) = 1 : 1

Trechmanute Platynite

AgoS AsoS. Phs Bass

Rl umbi hedral Rhomboheumi

## Zinkemite Group, Orthorhombie

Zmkenite Andorite Ludströmite

PhS Shah 2PhS 1gos 18h,S, 2Pb8 Cas 3BbS. Hutchinsonite Chalcostibite Emplechte

PLS TLAg S 231636 Cuss 85-S. Ch. S. B. S.

## Miargyrite Group. Monnelinie

Muargyrite Starthite

Agos Slas Agos Ass. Sartorita Larandite

PhS 4-S The Ases,

Matildite Aramayonto

Ags Bus, Ag5. Sb B. S.

GALENOMERM THITE PAS BIS. Berthierite

FeS Sp.S.

## C. Intermediate Division. RS (As,Sb,Bt)<sub>2</sub>S<sub>1</sub> = 5 4, 3 2, 2 1, 5, 2

Fulöppite Plagion.te Busnuthoplagionite 2PbS 38L<sub>0</sub>8<sub>0</sub> arms assess 5Ph8.4Bh.S.

Monochuie Monnelance Orthorhombae?

Raumhauerite Fizelyite Ramdohrite	4PhS 3A <sub>5</sub> S <sub>1</sub> 5PbS AgeS 4Sh <sub>2</sub> S <sub>3</sub> 3PhS Ag <sub>2</sub> S.3Sh <sub>2</sub> S <sub>1</sub>	Menoclinio Monoel.nie
Heteromorphite	7PbS 4Sb <sub>2</sub> S₁	Monoclario
Rathite Schumerite Hammarite Wittte	3PhS.2A <sub>8</sub> -S <sub>1</sub> 3(Ag <sub>2</sub> ,Pb S.2Bi <sub>2</sub> S <sub>1</sub> 5PhS 3Bi <sub>2</sub> S <sub>1</sub> 5PbS 3Bi <sub>2</sub> (S <sub>2</sub> Se) <sub>2</sub>	Orthorhombie
Benjaminite Klaprothite	(Cu, Ag), S 2PbS 2Bi, 3Cu, S 2Bi, S	Orthorhombic

## Jamesonite Group. Monochnic or Orthorhombio.

DAS SECT

Dufrenoyate Owyheeite Cossitte		2Pb8 As 8Pb8 2A 2Pb8 Bis	S., g.S.5Sb <sub>2</sub> S.	Monochan Orthorom Orthorhor	t bic?
Kobellite Berthonite	2Pb8.(Bi,St 5Pb8.9Cu,5		SCHAPRAC	ERTE PbS.	Ag <sub>5</sub> S Bi <sub>2</sub> S <sub>2</sub> ?
Semseyite		91°68 48	b <sub>2</sub> S <sub>1</sub>	Monoc	luore
Boulangerite Presestebenite Diaphorite			5.5 5.05 285.5 5.285.5	Menos	rhombie aure hambie

# D. Ortho-Division. RS , (As, Sb, Br), S; = 3 4

## Bournanite Group. Orthorhambic

Bournouite	2PtS CuS 3bss.	Lillianite	3PbS B <sub>12</sub> S <sub>2</sub>
Selemannite	2PtS CuS 3ss.	Withchemie	3Cu <sub>2</sub> S B <sub>12</sub> S <sub>3</sub>
Aikinite	21/h8 Cuss Bass		Art man analogs

# Pyrargyrite Group. Rhombohedral-hemamorphic

Pyrungyrite	3Ag-8 8b-8 <sub>i</sub>	Proustite	3Ag3 AsS
Pyrostilpaite Samsonite Kanthocomite Sanguinger	3Ago Stofa 2Ago Mao Stofa 3Ago Ason 3Ago Aoso?		Mernel etc Manochuse Manochuse
Guitermanute Stylotypite Falkenhaynite Tapataure	3PhS 1-57 3ChS 5bS? 3C S 5b5? 3Ag(5, Ic Ba S)	Te):	Monochue

Tetrohedrite Group. Isometric-tetrahedral

Tennentite 30n-S Andre

27 . 2 46.4

E. Besic Divi	sion. RS As, Sb, Br St = 4 1, 5	
Longenbachite	6PbS Ag.S 2As.S	Trachme?
Meneghmite Jordanite Goengarrita	4PbS SbS 4PbS AsS 4PbS BsS	Orthorhombie Monocame Monocame?
Stephanite Geocromite	5Ags Shes 5Pbs Shes	Orthorhombic Orthorhombic
Goldfieldite	5k 4,8 Sb,As,Bu, S,Te 4?	
Beegerite	6PhS BuSt	[sometrie?
	Polybasite Group. Monochin	ьc
Polybasite	9Ag S SI-S Pearceite	PARS ASS
Polyargyrite	12Ag-S Sh-Si	feametric
Ultrabasite	28Pb8.11Ags8.4Ge8s.28b,8s	Orthorhomiae
	A. Acidic Division	
in a single specime.  Viballe 17 is to dork rest in this mean at Mr are in Livingstomte red his a profi	For Form 1, 1900 and 1 does to monograms of the form over the form over the monograms of the form over the form of	tens  - a a 1 folia gras south  - a a 1 folia gras south  - b to come a d copt  - to come gray, some  - to come gray, some - to come gray, some - to come gray, some - to come gray, some - to come gray, some - to come gra

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Christian The 2R may a Beller of the most of Calor Sentences brings Christian, Ports May now the state of the sentences that he are the sentences of the senten

61 64 From Résidence and Vance, Romania

## B. Mem- Division. RS As St. St. St., etc.

Trechmannite tg i to Ri interpretare therein man to with ground e fair t.

High businessee. It a 1 . Court and stress seated come into from the finnesse. to but I get the my the mine twing that you't ethnical crystage but Alega de design a a committee

Maryr e Platyr e to the chestral Black and there is being to example II a

Fillum, Swedick

# Linkenite Group. Orthorhombie

#### ZINKENITE, Zanckenite.

Orthorh where forms h c = 0.5575 | Orthosh Crystals and dopt disfinel siders, see make exiging forms through warring. Lincomp faces longs for it and the month ploning many in

Comp. Press S S but 22 4 and none 41 h, and 6:9 = 100 Arrespe sometal in type error of the autonomy

Pyry etc. The text of the entry early in the effected the grant and the first of the entry the grant of the g el careta el el careta de la careta del careta de la careta del la careta del la careta del la careta de la careta del la ca Francis Co.

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to him to when a man again at the sea for man a sea method when a top to a form the sea of the sea Mentala with rooms to

# Margyrite Group. M moehne

Misrgerice Ag.S.Sh.St. In complex monoclinic restals, also a same W 11 - 7 25 1) - 1 of 1 per a plan thropic at the gr at a tern help and got Sire herry cold depletacy of a side. Burdingetic contact From Felabrance (Bara Spine Romanna Problem, Bohemm, In complex cresials from R a padorf near live erg from a From tour and Pour a From he wild tender one. Z., also as an I rescribed a Mexico. From the Plant and Silver City districts in bath, and the Ran belong forter I also do a

Smithite Age to 5 Monochus Crystals reson in a flattened bezagona, pyramis One prefer seavage 1 M , small, As of 0 D Z age  $z = 6.6^{\circ}$   $\eta = 3.37^{\circ}$  M = 1.5 2 G z = 4.9 C to leg by the banks  $\eta$  , prompted on exposure

to any Stream verminant. From the Barnertal Value we are a final de mondes de Sarmrise. Stream de Phil 1873, In a select of the products de mondes de to 64 they Jack Iron gran him a terrain to a the lancers to be an South

ertand, gemotorite in amilar but tricking

Lorandite The Asset, Months of Highly condition from lar of present of condition for the tenths of the Condition of the Condi I ver Auchar near Rozei un merthwest in Axionica, Macronicae Rate mer auto, Lueampment, Wyoming

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place a latrops of the less agree on a log of an its sure on the carried or to make the producer and it was the same though a make I in the Associated with partie and tetrahecrate from Chooses, Province of Suita airland, Admi. Denti de

ter his orient row. Fee Bish, also with AgiCu. Creates we columns to so pict. the standard of the standard o a property can be and grante as a street by a parallel I have a man a man, the service of the se go end-sensitive is move on an exercise stady to be a mixture of condite, sphusents, and hipper 1

Berthierite. First that I make measure grap for If I I ( - 10) I have there exist I so that I is a some which will not be the presence of which per infinite size with it to some one down one to contact shops are for the law of Kinney broads or homes a few or the le was to the a of the a street this breaking where Ong a over self from the 3 defeated by a Laboratoria se a de ameliardo e en al face de america sol con en en en de se amelia de la lacella de la contra del la contra del contra de la contra del la contra

continuent of Fredericton, Prince William, pared York Co. New Brightness.

## C. Intermediate Division

Pilifopite 1948 State, Monorain Crystanesten month, remote or rhon be-herral a habit. Les art tower grantent if the former than a forme 5.2. For lat hap Man 2.1. Mare through Nagorico a line in Plagamete Massaches, I grant have not a religious are not all pend-

get more in lythe made a 45 courses the rearranging from 1 to 15 35 to 5 5 5 5 1 1 are to sw vars note true to reason there. All are monoching to be seen a greated to a heavy togs has form a committee against such the vertical raw sec. property in an other transmission of the permitting of and the arrest to the which the shad bed at section where I trent there an expert to species. Motion will be be taken our exceptable growth by the section of the section of the 2 2 1 1 = 2.5 From We sleeg is the Laza Mile for additional at Language than a Northal In your two of france I can seem the Homerton Vanas, suggest in I is the write-

Branche planner to the transfer to necessarily extend postate postate transfer to the transfer

Jefferson Co., Montana

Baumhauerita. — 4PhS 3AaS. Monoclinic In complex crystals with varied halat. One newtool ciencage. H = 3 (1 - 5) Metallic - color read to steer-gray. Streak, chor ste-brown from he Horizonta, batas, Switzerland.

Pixelyro. - 3Pbb \checks & store Mono at r In terms strated prime. Cleavage (010) Third leads of steer-gramment Streak mark gray H - 2. Occurs with semsely-

ste at Residera, Cognita, ven er Rimona.

RAMOGENETE 3PhS tgs at so, In primate or thick intro-shaped crystals. H = 2 (, = 5-3% (coor gray black with blash tange "treak gray-black. Found with quarts and pyrite in the mine Chocaya la viera, in Potom, flouvia.

Heteromorphite. - 3 le d-automony sulpho-es, coterme tiste between plagaunté au-l estimate a see in her place on the Approximately "Phatishaps Minuclaid to a 1 3 H. - 2 A. From Arnsberg, Westprinks Washberg in the flare Min. Bottom. Turcany

Rathete -- 3PbS 2 torS. Orthonometric presents crietale Cleavage, hi010) Color entigers H = 2 G = 141 from the Romental, Sutterland. Williameter in approximately the assess appeared

Schumerite ig 1 S Bos. Massive granular G = 674. Color mod-gray. Treas is love (separa - not Park to a colors.)

HAMMARITE 198 | Sourpermaps Prof to 20 St Management Institut prisms of develop Clearage to grow H = 1 Court or engage with red tame. Streak bas 2 Frond a part at madeamous Property Ramar Sweden.

Witters of the R. See to a sumton or modern a sood cheavage Color light end-gray where was R = 1.15 = 7.1 there exist belon, hopparburg,

Sweeten with partie and in greater an iso to beginning on ph being referenting. Color gray on frost fraction, read a correct re. M. a street H = 3.7 3.5 Occurs with chalcop rate of rise are to a set to a size of the minimum of the Outlaw Man. 12 to the factor of N to the area of the Outlaw Man. 12 to the factor of N to the N

Klantothete. Name to to the state of the sed presents orthorhooding present to the state of the

Liermany

### Jamesonite Group. 2RS AsS., 2RS 8\S., etc. Monoclinic or Orthorhombic

## **JAMESONITÉ**

Monoclaric Axes a  $b = 0.8316 \cdot 1 \cdot 0.4260 \quad \beta = 88^{\circ} \cdot 36' \quad mm^{***}$ 110 A Lot = 79° 28 In revenlar crost de control in capitary formes also him a massive parallel or averget compact ransive

Cleavage has peried brackers never a coorbidat Britis H = 2 3 () = 55 cm | Laster metallic | 1 d r steel-gray to dark card-

Eris Street graves to extracted

Comp. - 25's stas, = sq p ar 1+7 artimony 29 5, lead 50'8 = 100. Most voru easte wat the from A to 3 per cent, and some commin also silver. cupper, and zine.

It has see suggested that the most mode is a are assess an integral part of the matter of the second of the second appropriate for it is Phys . . belongs to the material commonly ruled a worse I so home er became the transfer of the general and the contract the length to a many sengtion of the second phones read-reading at with teat attache and panese and c M d TWITE

Pur Name as he should be the

Obs Lancer . ' be are time agreement with other lead mutdiesed a guerns water a competer of a contract of a contract of the expert credited to januariste are in other other one regions in ar irrag in fairous form. The most important locatities for its occurrence are. Army Idka near Kosice. Kascha i or hassa , the neglecture to growing at an leading steel 1. I happened they are in quantity at his the soft as Dir me on at Acehan A, the autitiony times in bevier to , Aranaus, and

at higher Perman in Co in it Day do

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A arriver a second about to be probably a man are of states and an annionate. Compe-

the from St. on other narder is the product to be presented to per or the

Differentiate 21th ton, Max or It but a made of string and discovery bond perfect a 22 Strong turning turning and it is a fallow a contract against the strong and the stro

Owyheette Digitality of the digitality of mounts are all rature purp as crestals of bounders with a first of firmer even are the age original land to a gate of headers. Cone and store gray to a ver alone, you want affirm. Remark rest about the factor of the property of the Proposition of the City de-

Combite that they perhaphonds tomals measure ithmust continue it is to be a companied of the companied of th . I se he rime a Some att. Ver man I success by the structed to a distrito a the New Log of the great with Wales Originals to the control of the control Was righted I rectain them I have township originally reported as gaves as also and from Cohalt district.

Robeline 2198 Daniel S. F. broom reducted or grate due masaive G = 6:3 Color

Harry at a certage a from it cam, weather that the certage is the state of the special in the special The II a de the wind with games in at an other to the care a will The bits flas been executed increases the and appears to select the symmetry

s tarns tiera. The Age Buss. From Schapter's haden. A would as species prob-

ably a mixture.

Semistrice. OPIS 481, - For relations to plantenine and beteroploops to see motor plagnors of Money are the fathering court to the court of the payone of the payone to for the Black Man it Wolfsberg From Church Bonesa.

#### ROULANGERITE

Optiorbonalue Axes a b c = 0.5527 1 , 0.7478 In prospatie or tabto or crest as or crested a plantee trases gradual error at a manager (8) and 010: H = 25 } (1 = 17 to 3 | sever mer to tell r s apolygray after covered with yellow spots from exclusion Opaque Streak red-brown

Comp. 5Pis 28b, S. = Sulphur 18 9, antamony 25 7 lead 55:4 = 130.

Spring as for emberged p. 146.

Obs. I so to our work associated with other least it all smalls, guestin, withoute, tetra società esphatomia come cote l'oromanor y arminor y arminor y article de l'anticolor de l' per Best in the Superconstit Type at the tenth state of the second of th Correspondence from the Labe district, Newsday, and from Newscale Co. Washington Fratestate and a unboshbut are from Nerchank then are probable in our varieties of boundaryses. If and or from near M. the I take a apparent the well with contingerate. If the clauser must be seen assume common to travelly formula sPhensbush a probable since a particle of the program and galerys.

#### PRETESLEBENITE.

Monocutar Axes a b  $c = 0.5871 \pm 0.9277$ , d = 87° 46' Habit promoned H = 2 to a = 0.2.64 Laster detailed form and screak light steel-gray michology to shour white, also to black shield-gray

Comp. 5 It Ag 5 2555, or 24g 5 of the doct.

Obs. From Leserance an Expandence in Remains 11 Freiberg, Samera From the cases as a fittest a case of the example that example the same trainer, Spain.

broom topics the an a constraint

Displicate. The resistance of composition of orthophory of inform. H = 25 C = 34 from 25 metric of Principal Countries of the form the period for Zan ab C or in a reservent store for Las Por a Memory forms at the Last Chesa at the Act of the Administration of the

### D. Ortho- Division. 3RS 45-S., 3RS 84-S., etc.

Bournonite Group. Orthorhombic Prismatic angle 86° to 87°

BOURNOMITE. When the

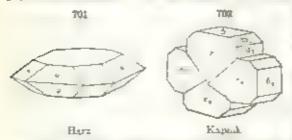
Orthorhombic Axes a - b = c = 0.9380 : 1 : 0.8969

 $\frac{1}{\sqrt{100}} \quad \frac{1}{\sqrt{10}} \quad$ 

cs, 001 \(\lambda\) 011 = 41° 53 cs, 001 \(\lambda\) 112 = 33° 15°

Twins tw pl is 1101 often repeated, forming cruciform and wheel shaped cryst as A'm times - stringar est pact

( earlier 6.01) a persent a 100 of 601 ass distinct. Fracture subconclude, to served. Rober builde: H = 25.5 for = 5.7.5 R. Luster



metadic billioni Comorata streak steer grav, incan agrablica di lead-gray or it -- mack Opaque Como PP.C. S

Comp. 2PkS Cu<sub>2</sub>S She5; Su phir 10 S, intime by 24 7 lend 42 5, copper 43 0 = 100.

Pyra etc. In the crosed to a decreptures, and green a tark on substitute. In the

open take gives malphands in the unit q whose sublimate a note of antimore at his in material functions are not as the content who are a most having government of head or an electron are the content of the gross again in the appear. Description of the unit of many at a most many area beaving a remarkable or supplied and a white power contenting two many area many area many a remarkable or supplied and a white

Ohn the range of a size the server common members of the value scale group. It receives a common to general the above of the control of the control of the state of the server of the server of the from I represent the server of the server of

Bonal crystals from the mines of Poutgiousi, Puv-de-Démir France, and from Cornwall. partir durty at Lascent and at Wheat Bove, hadedless where it was test to and and caused and it me by Count Boursen, after whom it was survey as a samed. In Bour a from the Pulacityo of the next Haster next to does up from Man extracted. From Casaptaca, Peril In the I proved binnes for the Bugge une bug Bug where I'v open to Are ma from Seligmann e 2 5 and here succeptions with the common or control of the

a b c = 0.02 at 1 000 at the strain, we resided 1 minutes, in one is bir itt. my two pl. Come leadings. (Therease press) if = ? he to at an ages such party, Bungarial, Yames an agreement experience of towers. White a real completion, tasks

Alkanie 2003 of Both to at example of the factor of the black of lead-gray from Bergares over Example 1 g. I m. Mix

Lidentie. The Rice Christian star Crystal de and missive. Cleavage 100' grost, 10 paint i air seel-gre. H. 2-3 (s. = 4), in bester from machanisms Kampar and from lens a benegment lakement (byte. An argent cross variety from the capes of the Lamin Mong Comparison, Colorado.

Withchesite Book Larely in cristals over hing bournoutic also massive
G. = 4.5. Cour steel-gra or an white Withches Bacts.

## Pyrargyrite Group. Rhombehedral-hemmorphic

PYRARGYRITE. Ruby Silver the Dark Bed Suver the

Rhombohedra-beminerphic. Axis,  $\epsilon = 0.7892,0001 \wedge 10\overline{11} = 42^{\circ} 201'$ 

Crystals commonly presume. Twins: tw pc (1914) often in multiple

twine also d(1120) And massive, compact.

Cleavage rt1011) distinct, e 0112) imperfect. Fracture conclus bd o uneven Britile H = 25 G = 577 5 % a 85 if pure Luster ingtal-

he adamentine Color back to grayjah banck by transmitted light deep red Streak purposh red Year.y opaque, but transparent in very thin granters. Optionly Remadive m.hees,  $\omega = 3.084 \Rightarrow 2.884$ 

Comp. - SAg.S.Sb<sub>2</sub>S<sub>2</sub> = Salphur 17 8, antimouv 22 3 suver 59 9 = 100 Some varuties contain sinal amounts

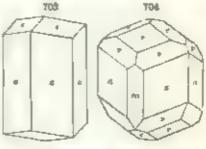
of amenic

Pyr, etc. In the inner tube form and gives a transit of the trade in the view to the

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Name and see at all approper other, to address to the order

PROUSTITE Roby Salver the Light Red Salver Che.

Rizonabol edra element replace Axis  $c = 0.8039 \cdot 0001 \land 10\text{ H} = 42^r \cdot 52^r$ .

Crystals often acute rhombehedral or sealenshedral Twins tor pl

me [014] and relott. Also massive, compact

Cleavage r 1011 distinct Fracture conchoided to uneven Britis 2.25 G = 5.57 and, 5.57 if pure. Luster idamentate Court service-vermillate streak some, also melined to aurora-red. Transparent to true a reget thrula view, we  $\omega = 3.0$ ,  $\epsilon = 2.7$ 

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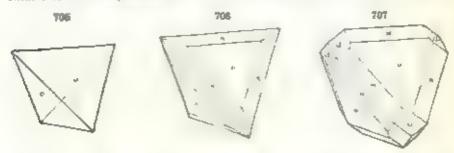
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transfert between the best of the transfer of the state o They fith A so a steel support house on I show peelings Dig. S.T. 16, S.Te., Strate of paradical apartment with the action of a telepolymate and argumite. Manages, granular G = 750. Sierra de Tapalpa, Jalisco, Mexico.

# Tetrahedrite Group. Isometric-tetrahedral

TETRAHEDRITE. Gray Copper the. Fablers

Isometric-tetrahedral Habit tetrahedral Twins two plocititity, also with partie of these (Fig. 4.8, p. 184 Fig. 4.0 p. 187) Also massive, grander, coarse or time, compare A-ray study shows an atomic structure elisely similar to that of sphalerite



Cleavage a ne Fracture subconcho dal to uneven Rather brittle. H = 3.4  $C_1 = 4.4.5$  ] Liptor Line is entry up a left. Character when thin-grat and combines streak are out, sometimes meimog to be will and cherry red by \$2.72 Opaque somethes subtransacent cherry-

red, in very thin splinters.

Comp. - Essentially a copper-animony sulph to The fundamental forms, a is probable. But show with a line state the structure as to make train a ray at it. The an ease, however show a te variations. and the immeria exactly the bound several semanticle industries. Prest an a strength that the state of the state of the state of 6 Zn I Salas Where and husing write the formula as follows, of up 2 to be Low 25 was

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#### TERRANTITE.

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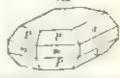
### STEPHANITE. Brittle Silver Oce.

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thronge but the mperfect brust resultcompellation in the little II = 2.25 G = 0.2.63 I ister metrice. Color and streak romblack. Opaque.



Comp. 5 Ages SteS<sub>3</sub> = Salphur 16 3, antimony 15 2, sover 68 5 = 100

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### Polybasite Group. 9R.S As.S. 9R.S Sb.S. Monochine, pupulochombohedral

#### POLYBASITE.

Monoclinic Axes  $a \cdot b \cdot c = 1.7309 + 1.15796$ ,  $\beta = 90^{\circ} \text{ O}'$  Prismatic angle on 2. In short six-sided tabular prisms, wit here isliedges (1004)

faces with triange far streats as, in part repeated twiks, tw. pl. in 110,

Converge cool imported Fractice uneven II = 2 3 G = 6-0-0.2 Lucer metalic. Color from black in this quarters cherry-red. Streak black Nearly sparse Optionally - n > 272 Strong turnfrangence Comp. 9Ages Stast = Sul, bur 15 0, antiquent 9 4 salver 75 6 = 100

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Ultrabagite Sept.S 11 kg.S 30 esc 250-5 Orthoras lige Color and stress area black H = 5 (, = ) from breaking tax ax

## 11 Sulpharsenates, Sulphantimonates

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#### ENARGITE.

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Comp. 3Cu<sub>2</sub>S A<sub>2</sub>S<sub>1</sub> = Sufr bur 32 0, arrenne 19 1, copper 48 3 = 100 Antimony is often present, of familiante

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### III. Sulphostanzates, etc.

STANNITE. Ten Produce Heliculeta the

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Cleavage culor indistinct bractist in even Britile H = 3.5 G = 13.4.522 4.505 Zin wild Laster netable Streak blackish Color steel-gray to conduct the former when pure, sometimes a bankle lastesh, often velle with the netable of chalcoparite. One is

Comp A sulphostaring of copper, in a and sometimes une

Cuss FeS SnS, = Sulphur 269 tin 275, copper 295 from 131 = 100

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cylindrite (1718-6868) 8 48, II = 2.5 a G = 5.42 Leuter metallic Color fascian colligias to color e al forma secola ag auter pressure into autoct abelia come l'empo, in Oraco, Bonesia

# IV HALOIDS. - CHLORIDES. BROMIDES, IODIDES; FLUORIDES

1 Anyhdrous Chlorides, Bromides, Iodifes Fluorides.

IL Oxychlorides; Oxythuntules

III Hydrous Chlorides, Hydrous Fluorides.

The Fourth Class includes the hard's that is the compared with the biogen cars now, the man bromine, assure, and man the less thesely related fluoring

### I Anhydrous Chlorides, Bromldes, Iodides, Fluurides

CALOMEL. Harn Quicksilver.

Torragonal. Axis c = 1 723, 001 A 101 = 59° 52′ Crystais sometanes

tabular | c(001), also pyramical, of earlighly complex

Cleavage: a .00 rather estated also will bracker concho id Scottle. H. = 1.2 G = 0.482 Luster domanting a new winte, yellow tall gray, or ash-gray, also graytah, and yellowed white brown Streak page yel outsh white. Translucent - subtransiquent. Optically + w = 1.97  $\epsilon = 2.05$ .

Comp. — Mercurous chaonde, HgCl = Chlorine 15, mercury \$5 = 100.

Pyr., etc. In the closed to se votat, use without fusion, condensing in the cold part of the end who is to see the same from a set there is the time the ed to the 

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to the Atom of the area of the and the manestra r avage to the light very transfer and the New York Wasan. Cuproceedings and from linguitagaya, Peru, whoags here was

## Holite Group. RCl, RBr, RI Isometric

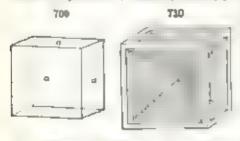
AgC Hallto N 4 1 Cerargyrite Embonte Ag Cl.Br) hs 1 Sv vale MLC Bromynte Agler So) Ammonuic Iodobromite Ag ( 1, lsr, I) 20 NaCl AgCL H inntagovite Vilantimite Nat

The Harrer Guerr trebides the balogen compressed of the closely related ne als, sodom, potassors and silver one ammonian (NII). They crystallize in the isometric system, the cubic form being the most common

#### HALITE COMMON IN ROLE BALT

Isometric Untilly to other crystals sometimes dislected or with cavernot been Thrate on serieture shows bornes symmetry or definite see p 36 but certain irregulant es a puis produced by etching have been thought to mel cate planetralesi symmetry. Also massive, grammar to compact; less of en columnar

Cleavage cubic, perfect, Fracture conchould Rather brittle. H = 2.5 G = 24.26, pure crystals 2 t64 Latter vitreous. Colorless of write also yehowish, readsh, blash, purplish. At times 4h we a Jeep blue



color which is usually ocalized a gregular spots. I has has been yarsously explained as due to the presence of collorial sochura, to a lower changle of sodum to the presence of organic matter, etc. Transparent to tripslacen. Sol. b.r., t. a.o. saline. n = 1.5442 Highly disthermulous.

Comp - Sodam chlorido, NaC. 

100 C stamonly mixed with extersin a diposite, as erom of linde, magnes um ell-rate and someti as tangingenta sulphate, which render it hable to designésee

Pyr, etc. In the closed v he lines, often wit decrepitation, wher fixed on the pintle to a trafe reduce the a control or report to a to a to go so rear total of a very charale provide state of an orienter of Thomas or a to have made at water

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Medand, Inshells. Wayne Manutse and Mason countries. Salt has also been found near I arrested the same and with gree in I be attain religious bods and in the south ern perton of the state at an or the leights should the a tree chall be his con a complements one hundred set or the state three in I am oth later them have not an . Harper counties In Armona in the transaction masses in the Verde Valley, Vavapat Lo In Nevada away the Varga River in ark in distorted crystale from Humbolds (From Borax Lake, San Bernar's Constraint Obtained from the waters of Country to Lake, I table In Outago month the enstern shore of Lake Huron in Brace, Huron, und larni ton our es-

time. The chief mee of any are for columns and present at the parameter, which per me also made from it, being who can the war facture of glam, etc., siewe ng. preputation

of other mulaim term and a circum another resists and as an increasion. H = 2.

The antiquete 2.5 at Agril in other resists and as an increasion. H = 2.

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terminated and presented cleaned to 800 c because a set (a = 25 thefractive stone = 1 so Found is nepheirte-avenue from the is and of ace, 2 reach to single

#### SYLVITE.

Isometrie. The storme structure as determined by X-ray study shows normal symmetry but because of eaching figures exists has long been consi level as beautiging to the plagnobedra cases. In sec. often with cerahedral truncations. Also in grait ar crystaline masses, cor pact

Cowage che perfect bracture meyer Bret e II = 2 G 197 190 Laurer vitroons Coloring, white this is recognish and from inclusions. Souther taste resembling that of constain wat but by ter

n = 1.490, Diathermanous.

Comp. - Persessian chloride, Re'l a Chlorine 476, potassian 524 -100 Sumetunes contains soman chloride

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Sal Ammongo to the record the accustation about concane timareness as at Elma, Venterial etc.

## Cerurgyrite Group. Isometre-Normal

An asomorphous series of either though in which either charide, brounds and od de may meet in very mg property na. The enggest in his been much that the name certify rite be ket as the group name and that the different sub-species be on a d in full as chlorappete, Agi, bromargymiz, Agitr embessie, Agr( 1 Br) victembossie, Agr( , Br, Li

### CERARGYRITE. Horn Salver

Isometric Habit cobic. The atomic structure is son or to that of habits. Twins tw pl of 111) I smally massive and resembling wax or both sometimes columnar, often in crusta

Cleavage, none Fracture somewhat conchoidal Highly sectile H =

1 1 5 G = 5.552 Luster respons to minmantine Color pearl-gray. gravish green, wherely to coloness, rarely violet-blue on exposure to the light time there sown transparent to translatent n = 2 to 1

Comp. Sheer columbe Age! = Champage 24.7 Edver 75.3 = 100

Some varience contain mercury

Pyr, etc. In the count the face without decomposition. It B on observed gives a gt or from the a term in and figures areas, present as satisficient with the firmer an heard in O h comparts an interme attractions to the flume line .

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### Fluorite Group

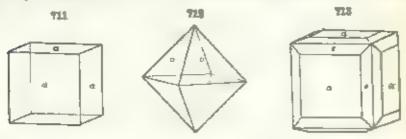
The species per hear of are Fluoric, all, and the rare vitorial rite. and ythrocerite

MINORITE OF FARMA STAR.

becometric. Habit cubic less frequently octobaded or distournestral forms (3,0 × 20 ) the common was the complex spinot. trate reserve the reason beg 71 : becauseboom to 12 againstrated at the color by 711 talse bystas se win, a groupe, in par net they are to firm a post of appropriate letter. But are for the content of a foreign erse, all the pards greet got got grante comes be faces of the stales con at twice of the times that have a rust of tracer two wins to be all to compressed a present a polymer and a first free free and a first and a first a fir the rare of the compact. The atomic structure of theme has the

calcium atoms arranged on a face-centered cubic lattice with the fluorine atoms lying at the centers of the eight small cubes of which the unit cell is composed see p. 41.

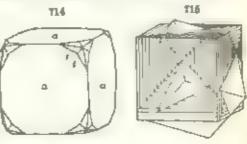
Chavage: o(111) perfect. Fracture flat-conchoidal; of compact kinds, splintery Britile H = 4. G = 3.01-3.25, 3.25 crystallized. Lister vit-



reous. Color white, yellow, green, rose and crimsun-red, violet-blue, sky-blue, and brown, wine-yellow, greenish blue, wolet-blue most common red rure ( clor often varies in different particle of the same specimen, showing bands

of different shades which he parallel to the cubic planes.

Further, the color may be modified by various means, such as heat, X-rays, radium rays, ultra-violet light, pressure, etc. Streak white. Transparent—subtranslucent. Sometimes allows a blanch thromscence. One p 275, Some deeply referred specimens appear blue by referred light and green by



transmitted half. Some varieties phosphoreses when heated p 275 and there when sentened with a kinde bade n=1.4339. Often shows abnormal birefringence which varies in bands that be parallel to the culio plates. This is probable due to internal tension.

Comp. - Calemm A pride, CaFe = Fluorine 48.9, calemm 51.1 = 100.

Chi rine is sometimes present in maste quantities

Var 1 (Anthorny a significally or existantized very various to colors (b) fibrous so one par, as the both shire shoe join used in vases and of companies a convex of the grant ar, i carte, i.d., and sometimes very soil. (Normalized phospharestent high when teasted

Pyr etc. In he bases tute berepitates and sometimes phosphi reseas. B B in the foreign and in charmail uses contring the fluore orange to an eranic which reacts although on test paper. Fused a a chood take with polasmin has I state at as the confor fluorine.

Dell Distanguable) to the creatains from occurrent beautiful relative a fineway as compared with certain precious stance, also with the foliasiars — etching power when treated with pulphane as —— These not effervesse with sec. 1—as cause

Obs. - Phorete may be farmed at her watery vary agreed thought free or as a gangue more is an a very more small of a crim deposits a which I is the chief constituent or as a gangue mineral with various a scalin orres, reported with those of read, shows any case of deep assertional with particular success surface, etc. It is characteristic of pine are not to be posite expected with those chrywing the arm been a semicisted with to undated to pure term being appealed at a found in softmentary rocks, as in dolumnts and ambients. It is also found as a

report accounts a letter of grant and "they are I species rocks. It occurs as a substitution

IN A S S M P P P 65

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brown on exposured seto endstoon. a - 1.59 Pounty Carble Astrongent taste Found in Corntains as Wolfermanages and Nordhausen and observate to Southly and near Dickbourn, Hanover

#### CRYOLITE

Monoclinic Axes a - b - c = 0.9663 - 1 - 1.3882,  $d = 89^{\circ} 49'$ . mm ' 110 A 170 = 88° 2' ck, 301 TO1 = 55 17" σ, '001 ^ 011 = A 14 σρ, 001 ^ 111 = 63' 18' (0)1 A 1 0 = 80 52 III.  $00. \land 131 = 55^{\circ} 2$ 

Crystals often cubic in aspect and grouped in parallel position, often with twin lamelle. Massive. The alonge structure has been at own to be similar

to that of garnet. At about 570° C. changes to an isomet-

rie modification.

Parting at times due to twinning lamella paradel to c(001), m(110) and k(101). Fracture uneven. Brittle Q, # 2.95-3.0.  $H_{\rm c} = 25$ . Laster vitreous to grenay: sumewhat pearly on c(001) Coloriese to snow-white, sometimes reddish or brownish to brick-red or even black. Transparent to translucent Ontically +. Ax. pl. 1. (011) Z A C BXIS = 446 1.3396.

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 $2V = 43^{\circ}$  a = 1.3385  $\beta = 1.3389$ ,  $\gamma =$ 

Comp. A fluoride of socious and administrative NagAlly or 3NaF AlF, = Fluorine 54.4, aluminam 12.8, sodium 32.5 = 100. A attle iron sesquioxide is sometables present as unpurity

Pyr, etc. - Franks in small fragments in the flame of a camble. Heated in C. T. with potageture buttle, battle given Summer reaction. To the farcete I see very case v, color u the bunner many. On harve as forces easily to a court bend white it coming for more operate, after long bless g, the assa spreads at the florence of wear in min served a the coal a cuffe a og stor of Garrine is given off and a crust of all and a rete on which, when theretael with entired and time in O.F. gives a due count. Soluble is adjubine acid, with evaluation of the institute of the count.

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ting resembling out a character and sufficience are a nucleonate.

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flux in the electrolytic process, at the process of more of more of a conference of the Carlothian terms of the conference of the conferen to - 2.78 Colorious or white n = 1.34 Occurs associated with cryotate both at Iviging and in the Bhinn Mia.

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### II. Oxychlorides, Oxyfinorides

#### ATACAMETE

Orthorhombur Axes a b e = 0.6613 + 0.7515.

$$\alpha_{\text{CC}} = 110 \land 110 = 68^{\circ} \text{ N}^{\circ}$$
 $\alpha_{\text{CC}} = 111 \land 111 = 72^{\circ} 48^{\circ}$ 
 $\alpha_{\text{CC}} = 111 \land 011 = 73^{\circ} 1,$ 
 $\alpha_{\text{CC}} = 110 \land 11 = 36^{\circ} 16^{\circ}$ 

Commonly in shorder presents crystals, vertically strated. Twins seconding to a complex taw. Parable countries two manufactures also massive,

fibed crystalline aggregates also massive, fibrous or grander to compact as a not (leavage 5 11) highly perfect fracture commends. Seattle H 2.45

ture conclude. Bratile H=3.35 G = 3.76 3.78 I tenter adminstrate to vitrous. Color bright green of three standes, dark crosen degreen to the said green Strack appre-green Transparent to translucent. Optically -. As pare (100). X=b axis.  $2V=7b^*$ , p< q, strong, a=1.831,  $\beta=1.861$ ,  $\gamma=1.880$ .

Comp. — ( u' l, 3c , ( H , = ) ) + nne 16 8, capper 14 9, cappe oxide 55 8, water 12 7 = 100.



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### III Hydrous Chlorides, Hydrous Fluncides, etc.

#### CARNALLETE

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### V. OXIDES

- I. Oxidex of Silicon.
- II. Oxides of the hemi-Metals, Tellianum, Arsenic, Antimony, Biamuth; also Molybdenum, Tungsten.
- III. Oxides of the Metals.

The Bittle Cigor that of the Oxnora, is subdivided into three sections providing to the new we carmen present. The oxider of the non-meta, when we placed by a reclaim, but as he noted that the compounds if the re- of same titing in are delived with their of the metals proper Il who would necessary by the fact that in our of its forms 1:05 to isomorphone with MnOs and Plats

A series of oxygen compounds which are properly to be viewed as salts, eg, the species of the Spinel Group and a few others, are for convenience also included in this class.

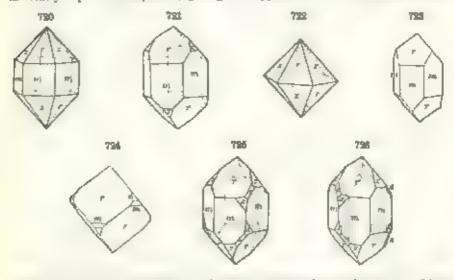
### L Oxides of Silicon

### QUARTZ.

Rhombohedral-trapezohedral Axis: c = 1.09997

er',  $10.1 \land 101 = 85.487$  ms,  $10^{7}0 \land 0111 = 66^{9} E2^{9}$  er,  $10^{7}1.1 \land 0111 = 10.187$  ms,  $10^{7}0 \land 1.21 = 37.587$  ms,  $10^{7}0 \land .011 = 38^{9} 13^{9}$  ers,  $10^{7}0 \land .011 = 32^{9} 17^{9}$ 

Crewtals community prismatic, with the  $m(10\bar{1}0)$  faces horizontally stricted, terminated community by the two rhombobedrons,  $r_1(0\bar{1}1)$  and  $z(0\bar{1}1)$ , in nearly equal development, giving the appearance of a heragonal pyrismather.



mid; when one rhombohedron predominates it is in almost all cases r. Often in double ax-sided pyrantils or quartizeds through the equal development of r and z, when r is relatively large the form then has a cubic aspect or = \$5° 46'). Cristals frequently distorted, when the correct orientation may be obscure except as shown by the strictions on m. Cristals often elongated to accessive rhombohedrons with the prism. Occasionally twisted or bent. Frequently in mainted masses with a surface of pyramids or in drusts. That quartz has a complicated atomic structure has been shown by X-ray study. The salicon atoms he on three interpenetrating hexagonal lattices which have in the vertical direction a spiral armingement in respect to each other. The oxygen atoms are apparently grouped in a tetrahedral mainter about the silicon atoms. The nort cell contains three silicon atoms.

Quarte is enaptionsorphous and simple crystais are either right or left-handest. On a right-handed crystal. Fig. 725, the right inguine pyramid - 1121,, if present, less to the right

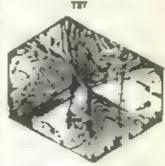
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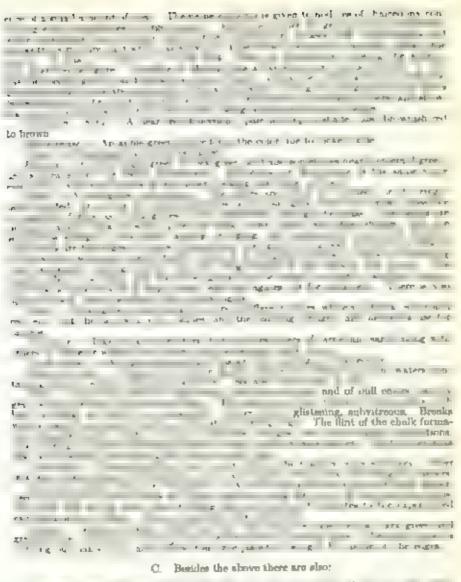
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### TRIDYMITE.

Hexagonal or pseudo-hexagonal Aris c = 1.6530 Crystals usually minute than tuburar - offer, often in twins also united as fan-el-ped

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Conclordal fracture H = 55-65 G = 19-23 when pure 21-22.

Luster vitreous, frequently substitutes often me ning to restroug, and monotomes to pearly. Color white vest world frown green gran, and genone y page back reduces arrest from foreign and maximum wor in was nich as of large or inflerent colors on retrue of and reflected agut. Streak whose Tre-sparent to nearly opening a = 143

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### II Oxides of the Semi-Metals, also Molybdenum, Tungsten

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et Mar, Somera, Mexico From the Propare faurict, Nevada.

### III. Oxides of the Metals

### A. ANHYDROUS OXIDES

I. Protoxides, R<sub>2</sub>O and RO.

II. Sesquioxides, R<sub>t</sub>O<sub>1</sub>.

III Intermediate, RR(U, or RO R(O), etc.

IV. Dioxides, ROs.

The Apply from Oudes metade, as shown above, three distinct divisions. the Prote votes. The Sesquiposities and the Dr. access. The recomming In ermen, ite linear circules a namber of oxyget compounds which are pre-write to be regarded them at any salts of certain acids a um mates ferrates, etc.). here is out that the well-characterized Sarver, through

Am ing the Protox desither the distinct group is the Pennelant Group, which includes the rare species Perickies, Mpl, Mangon site, Mat), and

Bussente, NV) All of those are nometrical crist 1 z con

The Staphoxins met de the wed-characteries Havaitte Guorp R.O. The Proxites it carries the prominent Ruttle Gnour, Rus. Both of those groups are further defined beter

### L. Protoxides, R<sub>2</sub>O and R<sub>3</sub>O

CUPRITE. Red Copner Ore

Isometric-perio bedied. Commonly in octobedroist also in cubes and dedecate strongs for highly modified. Plags sheared faces semetimes distinct. been p. 87. I this study shows an atomic structure with permiss symmetry. The copper atoms he on a face-centered rathe lattice and the oxygroate his on an appropriational lands conferred cubic lattice. This structure does not explain the plage tootal forms a menines observed. Etcling figures also indicate norms, sammetry. At times in capillary crystals. Also times save, granular, semetimes engthy

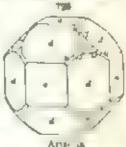
479

Cleavage of 11D interrupted Fracture conchotdal uneven Britis R = 15.4 G 5.5.6 b Laster administrate population to parts Cor pet of varies shouse part in your coret, who blues subject they measure a conductoral by the control of

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## Comp. - Cuprous conde, Cu<sub>0</sub>O = Oxygen 11.2 copper 58.5 = 100

Per etc. I an terrel in the cuses of the Bill to the Capage Care an expens the end there to be a send for the transpleat & a met matel me i to and will writer a a grate, a c

pre- te of cuprous chlorids. I B. In a complete at any ferror have even but in agriculture can see

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### Periclase Group

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#### ZINCTER. Red Oxide of Zinc.

He vigina, turn mornine Axis c = 1.5870 Na iral crystais rare (Fig. 41 p 25 usuals to ated these vt. It ill course part cas and grains also was grant or a recture. Lat atomic street ire is cosedy regard to that of

greenockite and wurtzite.

(% vage of NR I perfect prismatic sometimes distinct. Frantise subcore and Brett H = 4.45 G = 5.45.57 Laster supadamentine s nick ominge yellow. Color deep red also orange or leas. I far color as thought to be due to the presence of manginess oxide. Trusheent to subtractions that the  $\omega = 2.043$  ,  $\omega = 2.020$ 

Comp Z ie ox 1 ZnO = Oxygen 107, zne 803 = 100. Manga-

nese pretoxide as conditionaly present in varying small amounts.

Pyr, etc. If D in . the with the Busin on the platining wire gives reactions of inaugue one and on course too R I give a more forget por many and a war and and we can exp Part of second with a but so than and prested a OP as entropy a proper with the second or the second

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Bromeilde Act Hexagonal homenous lie G = 10.7 H = 9 Optionly + aut. 1 Sover etc.

Massicot. Lead as non-re Pld). Measter wals or earthy failer value redship Marine to also you warm a good white of water of the ces in . he crystal The branch of the transfer of the best were to be not been some that the legal of the second of the the control to make A mre materal of secondary striges occurring associated

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time econs (at) The are pseudo-monories in our to black Tennate Branch with operation, after H = 5 4 4, - 6 . The read of higher a great to the firegree to at a mount of the best town of a free earth rought men of a I to appear to the latter of peter models are not common to a light of center. I for the between the formal new point forter who will be and Thereseer forther and queen Horar Michael and result in the area this see for the Files disk market and there are with a policy terrore who and realwhite for History America and been course marries to This has been shown to be a variance that its of tename, surventions, Bits I to a market of

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Montroyders. Hgd Or tentered at the name to bighty module creately Clearnge O perfect H - 1 - 1 or and strenk range and Openous + a = 2.37 3 - 2 .0, 7 = 2-63. Volume. Fo and at Terungua Texas.

## Hematite Group. RaOx Rhombohedral

		C
Corundum	Al <sub>2</sub> O <sub>3</sub>	1.3630
Hematite	FerO.	1-3056
Ilmenite	Fe, Mg O TiO, Tre-rhombohedral	1 38 16
Senarte	(Fe, Mic Pb O TiO <sub>t</sub> "	1 385
Pyrophanite	MnO.TiO <sub>4</sub>	15092
Gerkiente	MgO TrO <sub>i</sub>	1 370

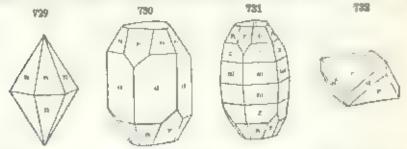
The Hematite Group embraces the sesquivades of sluminum and iron. These compounds crystall to in the rhombidization cass, hexagon a system, with a fundamental rhombidization differing but I, its in angle from a cube Both the innerals belonging here. Hematic and Corup Jun. are hard.

To these species the transfer of iron, magnesium, and marganese. Ilmente, Senate. Pver train v, and translete are closely related in form though beauting to the transletohedrarchas (phenacute type), and in atomic structum. It is to be noted further, that better the centrals than un, and at artifical isomorphous compound, Lath, has been described. Hence the ground for writing the formula of dimente. Fo, Trady, as is done by some authors. It is shown by Penfield bowever, that the formula (Fe, Mg, LO) is more correct. For other transles see p. 688.

### CORUMDUM

Rhombohedral Axis c = 1.3630.

Twins twipl r(1011) sometimes penciration-twins, often polysynthetic and thus producing a laminated structure. I ryst as usually rough and rounded. Also massive, with nearly rectangular parting or pseudo-cleavage.



granular, coarse or fine. X ray study shows a compacated atomic structure. The structure can be akened to a deformed habte structure in which the two different atoms are replaced by countranorphous Also, groups

Parting c(0001) sometimes perfect, but interrupted, also c(1011) due to twaning, eften promatent, a 1120 less distinct. Fracture univers to enchords. But the, when compact very wigh. If = 9 (2 = 3.9.44) Lister a jamantine to vitre us. 1 c sometimes pearly. Occasionally showing asterism. Color blue, not, yellow, brown gray, and nearly what, streak

unerland. Dehrote in teeply collect vapeties. Transported to truehereat. North a print a pegative for supplying w = 17676 to | 7682 and = 1.7894 to 1.7598 (then at cormady maxim.)

There are three at the season of the seasons proportion the recognises, in the arts.

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Comp. - Alimana, A. O. - Oxygen 47 (, alemanum 52.9 - 100 The creat, and victories are resent any pain containing a via title forme on a ne latera. The year at a same one rare perhaps due to the preserve a varying n serie among a different remains and only more existent disnivary dispersy Blow Holls of the High Park, the first property

Artif ( ... or or ... or or or or ficially at a not open of there. get was to the day of the galage The fact has the first of the control of the contro the second of the second district the second of the second

The state of the s a part by as the line reserves have a more opens. Do that a survey with partners in

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Maro. In this sections of white there's should with high record and low interfer ence colora.

Obs. Later to be at acceptance and in capable the market as great by the The property of the property o The state of the s terrent to contract today we want of recent materials to the cause therapy on prismes for its realled

masses, accompanied by grains of magnetics, and several kinds of gents, as spinel, etc.

The emery of Agia Minor occurs in granular limitate in

The best rabite come from the names in Upper Burna, north of Mandalay in an abea revering 25 to a square the discharge Mogak is he collect. The rabites occur to see in crystall on directore, also in the a of the balances and in gene bear og graves of the Irrawaddy River. But supposite as well as stones of many other roots, are tomight from Ces on from the Statusphra and Makwam laurets often as rode at des also as we inpreserved crystals. These him suppliers and also roding from a bleast of limitable over Betton day in Lan soon and Chantshun is the fact stones come from rational parts of indea and also large coarse creases a the Carmina one act of a there Medica, pure of main and uses large course to example the country of the first many and and in Courbators and M were. Suprames and provide the country of the frame Kashmer, nowhere India. Presents of tabular cristals for grey to be all I have from Takayana, M.no. Jayan. From the fame. Mits. at East and M.sak. In Thomo. Swazerland, at Campoungo near at Gotthard with a rea or like to get a following large sprague crystals and quesses from various packs a. Macantonical particular via micra. sense at at latendrang and elsewhere southeast of Antenahe, also in creature and resid per des of gem quality in annous occasion. Large opeque er vines are found at Stee kepf. National mannet. Tape Province. South Africa, and in the Zoutpassoerg and Preteresturg. dutricis, Transvani

in the Union States corundum occurs in Orange Co. New York at Warwick, househ and pink with spinel and at Annity white blue rodded crystais. In Sussex Co., New Jersey at Franklin Formace, at Newton in blue crystale, at Verous a red coverale at Sparts, etc. In Peans; vanus in Chester Co., at Command 14th pear, moneyar Newlin township, was abundant in crystage and large masses, and in Delaware Co. in Aston township. ship in large creatals, also in Leh gh the la. Shimuray, a common at man is les ableng a tel, extending from Virginia accous western North and South Carolina as I Congra to Dud syville. Labama. The locabres at worth most of one was to be were force of the life was branklin. Macro Co. North Carolina, and southeast at Lauren Cress, Court a Green southers are found near field a Montana, in gold weekings up in ours of the Manual Report of the Manual Repor some River especially the bosomore Bar at 1 age Grich on the Jon in little where they make occur in an andemic time offer also at other localities. In Unitaria corne into occurs in that there to even tee and an oth site in the south central styl eastern country, repercently a Hastings to in red and blue crystan at South Burgess in Leeds Co., and in

many names in Renfrew ( o

Finers is found to the faluel of Name and elsewhere in the Cyclades, Greece, also in Ama Monor east of Pohesias in the mountains of Chine Dagle Messages and a value diamete north of Sayrna. In Massachusetta, at Chester commun and emery occur in a large vein.

Clear varieties of corund-on form valuable geny stones as noted alsays Use . former, largely used as an abrasive, at present various artificial abrasives are mostly

then materi

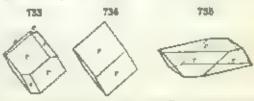
#### HEMATITE.

Hombohedral Axis  $\epsilon = 1.3656$ .

un', 10% \* Tion = 37" 2" er, 0001 ^ 1011 = 57° 37 nn , 20 (3 / 2)23 - 5, 50 en, 0001 / 2243 - (3 13 m 1011 A 1,01 - 04" U ar, otia A intz - 84° 51

Twins: (w. pl. (1) c(0001), penetration-twins. (2) \( \tau(01\)\)\( \text{12}), less common the unity as polysynthetic twinning  $h_{\mu\nu} e_{\mu} x_{\nu}$ , producing a fine struction on  $\epsilon_{\nu}$  (000)  $\epsilon_{\nu}$ 

and giving rise to a distinct parting or pseudo-chavage r(10...) Crystals often tuck to thin tabular c, and grouped th parallel position or in rosoltes, a faces striated edge old (0112) and other forms due to user latory combination,



also in cubs like shombahedrons, rhambohedra, faces 5(1914) Forizontalis structed and often rounded over in convex forms. Also columnar to granufor botryoidal, and stalucture shapes, also famellar, laming joined paralel to c, and variously bent, think or thin, also granular, frishle, earthy or compact

Parting: c(0001) due to lamellar structure, also c(1011), caused by twinning. Fracture subconcatoidor to inneven. Brittle in compact forms, classic



in the laming, soft and inctions in some loosely adherent scaly varieties H=5% 65. G=4.9–5.3, of crystals most 4.5.20.3.25, of some compact varieties, as I was 4.2. Laster treatment and recomment span cut sometimes dual. Color dark steer-gray or non-black, in very thin particles blacking, by transmitted light, when carriered. Streak observated or reddish brown. Opaque, except when in very thin laminas

Ver I Specular Laster metallic, and expetute often spiendent, whence the range specular term W an Go strop are in fillated a mercency, he are a aloca macroscop to make a record to the process a varie or are soft and impression Suggestation of magnetic on probable of a configuration to Aris 653 455.

3 to a course Red mad earthy. Reddle and red chail are tree more quantiles to

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Comp. — Iron sesquiexide Fe<sub>2</sub>O<sub>1</sub> = Oxyger 30 aron 70 = 150. Somenes of utains thanking and ranguesium, and is thus closely related to dimensite, [456]

Pyriete RB of other or charcoal in RF becomes consists with most given a state for the With the property of the temperature of the state of the stat

Out the grown of rooms aggretate by Jured streak who from thoom to by the same means, as well in the reason of it is 'g water from targets or deign or to the essablish and to give the property of the same of th

Artif (remark) a character one obtained instrument error bank by steam at a left the tradeour as I upon too. How a character of the best of standards from Various artificial imaginate, would thank communities or no ferrous too.

Obs. It is not a definited in various ways and a forms to make of all ages. It occurs to connection we see any last testine as a scheme con product, make as seems him cross to plates and tool ages has a last before any or solutions. It is presently stratures by the notion, of water vapor applies of the left before a formula age of ages of sakes before the product of the grant testines are not seen to the product of the grant testines are not before the national testines at a liquid and the product of productions. It is not occurred at the metaporaghic rocks, as times in

485 OXIDES

hole of great thickness where I may have engrated to the attention of these to effecte,

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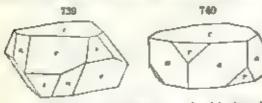
these and age estimated in the second of the or the black frequents Constants the a temperature New Presting and Now the Park

Lie The set a set of the set of t  HAMENITE OF MENSOCANTE. Thank Iron Ores.

Tri-rhombohesiral, Axia c = 1.3846.

er, 0001 A 1011 = 57 8814. m, 1011 / 1.01 = 94 .57. m, 0001 / 2343 = 61° 58'.

Crystals usually thick tabular also acute rhombohedral. Often in thin plates or lammar. Massive, compact, in embedded grains, also house as sand



The attente structure is singfar to that of corundum, posviding cardadt of the latera Al atoma be repriced by he and the other had by 'fi.

Fracture corrhontal H. = 5-6. G = 45-5. Laster submetalite. Color mut-

black Streak a bract the powder black to brownish red. Oraque.

ences elightly the mag, etic needs

Comp. If normal, he has or FeO. TiO<sub>3</sub> = Oxygen 31 ft, titanium 31 ft, from this = 100. Sometimes written (Fe, I ost), but probably to be regarded as an iron tit-mate. So tactimes also contains magnessian (prevolutaride), reparing the ferrous tron, house the general fermula. Fe, Mg O Troy, Penfiel Catapara gether te, p 487) The variations in composition the win by an , vers age in part, at least, cuplanted by the fact it it specimens dien show a rog that interest with if have beef being to or magnetite, in a manner abaregous to the pertintic intergrowth of the fealsters.

Pre-sta - AB of - de n OF although slight y rounded on the edges to R F With a car as I would be consciously or one of the second the second a second a to the or series a complete with the compact of the treatment with the compact of the to present the large tentor to the transfer the restriction to he to be he had been as a set of a control of the set to the head of the head

D.C. I see see he had, a, to thus so morally, nearly much, etteck not magnetic lier z r e

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The second tent to a secretical entertial and the second s Wennes for a fixture transfer from him home or with any of the core to present and the first for the present and the first for the present and the first for the present and the first form to the first for

the condense the newest a in reserve a Quebec experies at the values as the temperature of a good of the vectors of a feature flow on a fact that the process of a feature flow on a fact that the process of a feature of the temperature experience, the many of the process of the feature of the form of the fact that the process of the feature of the fe Sena to Fe Mr. Phill TiOn Frontis adversary to the style and branch of the style of

487 CHARLES

Pyrophanite. Minganose titanate, MnTiO<sub>2</sub>. In thin tabular rhumbohedral ervetals on scales, near discrete in form p. 480; H = 5 G = 4.55; Lester vitrouse to scome a tr. 1 our deep bloodered. Streak other verlow. Optically  $\mu = 2.181$  = 2.210. From the Harmog mine, Pagaburg, near Persberg. Virtuinal, Sweden, also at Greeke a near the products. Surface to the Press. Virtual Corner. Brazil.

Gethrelite. Magnowim fron trianate. Mg.Fe TiO, Heragona, rhombeledral. Structurally closel, summer to livenize liqually massive, as rather publishes. R=0,  $t_1=1$ . Color of set or brownesh black. Optically  $\psi=301$ ,  $\psi=198$ . From

the gett gravels of the Rakwans district, 6 evion.

Burbyite - Fe Mn  $O_h$  In black sometric crystals. X-ray study shows a body-centered cubic lattice with subsemi noticenses to the and ref. H=6.65 G = 6.45 Occurs with topas in cavities in thyo to from Utah Noted at Ribea, Girona, Spane, and in Valle de las Phinias, northern Patagonia.

Högbomite Roegbourde An oxide corresponding to RO  $2R_cO_r$  with  $M_cO_sPo_{co}O_{co}$ . Mgd for chaefty Rhombohedral, c=1.56 for a black Gravage apperfect actually to base and chambohedran fracture concludes. H=5.5  $\Omega_c=3.81$  Ogitation w 4 1853 a = 808 Pleochruc F bright velian bersen & dark petern George as a rock-making natural associated with rop over, magnotice, meta-c, pleanaste, or candide etc. in the Roomlevare hasriel Lapaniel. Also learn in magnet becur in our, are at has man't a Sondmare, Norway Dientified to mare-copic form in a speed emery near white or, buguan

SCHARLER BLOCK Most Most SCAO Not revetabled Good degrage H = 7 Control Chart bears, Central Provinces, India

Aggressarrance 3Man, 2500. Cleavage model to occasiodron or terragonal remail R = 55 G = 48 Color broate to lark cool gray. Stock dark brown strong magnetic Completete soluble in ac is be not at Be langue. District Nagour. Centru, Provinces, and at Grayufi, District Visagopatani, Madras Lotia.

### III. Intermediate Oxides

The species here included are retained among the oxides, although clemcally considered they are properly exygeness to aburn sites, ferrales, maderates etc., and hence in a strict classification to be placed in section 5 of the Oxygen-salts. The me wed-characterized group a the Spinel Group.

# Spinel Group. RR<sub>3</sub>O<sub>6</sub> or RO R<sub>3</sub>O<sub>5</sub>. Isometric

### Aluminum Spinels

Spinel

Ceylorate pleonaste, ferro-picota e Magnesenchronice, parotate

Hercytute Prestate

( br saherevnite Calinite 1 terrelite) Dystuite, Kreittomte

Galaxite

\[20 \]<sub>2</sub>O<sub>2</sub> (Mg be OrAl, Fostly Mg FetO (Alteriol) Pio Mo, the Mg O (M.FewO) bett, A. Cratte 2rt) A () (Zp.Mg.Fc.Mn)O. Al.Fc Or Minte, Mg D ( L. Fried)

### Iron Spinels

Magnetite Magnesioferrite Franklante Tacobalte

Fee FreDr Mg be 1 Fistly (It Za Mn O To Ma), Ch (Mn, Mg, O Fe, Mn , O,

### Chromium Spmal

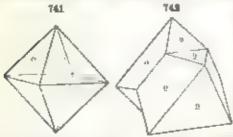
Chromite

FeO Cr<sub>2</sub>O<sub>1</sub>
Fe Mg)O (Cr<sub>2</sub>Fe)<sub>2</sub>O<sub>1</sub>

The species of the Spinel Group are characterized by isometric crystallization, and, further, the occahedron is throughout the common form. X-ray states show that the members of the openel Group have the same isometric it one structure. This same structure is shown by a number of artificial compount is having the same type of chemical molecule as well as by the minimal hangue (cf. p. 440). For spinel the structure may be described as having the O atoms arranged on a face-centeric cubic lattice, with the Mg atoms living in the center of cerahedrid groups of fact O atoms while the Al atoms are each surrounded by a group of six O atoms. All of the species are hard those with nonmetallic laster up to 7.5.8, the others from 5.5.6.5.

#### SPINEL.

Isometric Usually in outabedrons, cometions with dedecahedral truncations, rarely cubic. Twins, tw. pl. and comp face of 111, common. Fig.



742), benon often called spructurns, also repeated and polygynthesic, producing two lametics

Cleavage: o(11) imperfect.
Fracture conchoids. Brittle. H.

= 8. G = 3.5-4.1 Luster vitrecuts, splendent to nearly dull.
Color red of various shudes, passing into blue, green, jellow brown
and bluck; occasionally almost
white. Streak white Transpar-

ent to nearly opaque Refractive index: a variable with composition, 1.7155-2.00.

Comp. Magnesian alamante, MgAl $_{\rm c}$ , or MgO Al $_{\rm c}$ 0, = Alamina 71 S, in general 28 2 = 100. The magnesian may be in par replaced by ferrous iron or manganese, and the aluminum by ferrous iron and chromours.

Var. Rear bears, or diagnosis by and Clear red or redd the transparent to transferent superinter no transferent to the second of a superinter of the second of a superinter and the second of this beer as the The table of the second of bears as the The table of the second of bears of the second of

Carrier or Phononte From Magnetia Spaniel. Color fark green brown to black mostly of any or or nearly st. \$\langle = 3.5.2.0 \text{ Continue in regulating the magnetic immand perhaps also the normal herose the form in Mg to 0 Mob or Mg be 6. Although

than at or has been wire jerne in 2015.

Manager a movery Property or brome-Spatel Controls before and also has the observation args y replaced to any. Mg be to Al Cr. 20, hence I mg between quest proper and broth to G. - 4 35. Codor dark yellowed brown or green, she brown. Transferent to hearly spa per

Pyrick BB alone of make Showly soluble at tortas, more readily in sold of phosphorous, with which gaves a residual board while the foreigning faint chromo-group conceasing three arrests give react of the row with the fluid soluble way confined to remove and the soluble the fluid price of the soluble that the fluid price of the soluble that the fluid price of the soluble that the soluble that the fluid price of the soluble that the soluble that

Diff. I have guided by the orthogens form a runess and of assistant, zarous has a lagher upon a great to the true many profess as harder and a distinguished optically, garner is suffer and up the

Micro. In this section shows light color and high relief lantropic

OXIDES 489

Artif Arteficial animal creatals may be obtained by denot creatal sation from the pure of function of the pure of

Mer was a first of the state of

to the property from back to be sever money for the former a later of the sever and th

The last two two re was common are H = 12 and the grant are H = 12 and

### GARNITE. - Zinc-Spinel.

Imported Hand occulosed often wit faces structed oder between did overland and one of the old outside the and

medit centure I want in plantil

Converge will and the let the countries of the innerent British H = 75.5 4, 10.40 %, = 152 h the laster, results at the what group to declark group gray strained declar gray at group the track provides which, or gray at brown, streak gray at Subtransparent to nearly opingue.

Comp. — Zine aluminate, ZnAl<sub>2</sub>O<sub>4</sub> = Alumina 55.7, zine oxide 44.3 = (60) The gine is sometimes replaced by manganese or ferrous from the aluminum by ferric iron.

Var - Automotite, or Zine Gabrate. ZnAl,Q., with nometimes a little from G. = 4 1-145. Colore as above pases

Drugters or Zine Manganese-from Calante - (Zn, Fe, ManO Al, FonO, Color yel-

I make I share or grayash orona to 4-16.

EXECUTION TE, OF Zim. Into Galante. Zn.he.MgiO. Al FosOs. In crystals, and from the mississe. H. = 7 8. Cr = 4.48-4.59. Color velves black; In a ler gray as greed. Opaque

Pyr., etc. to es a con og of sine oxide when treated with a mixture of borna and

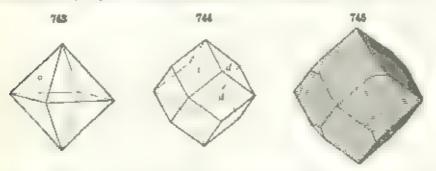
such as charcoal otherwise like spinel.

Obs. Call e w main cor conente and man, like pleomaste, as a contact uniteral and in the evistamente teleste. It out in large crustals at doduminas Bearina Arcetone as Sweden as a throne order to hear Fig. at Especialist atomic to the three total States of the are translated. Measure well as the Jersey at a panelin and Sterling I to figure A rought er at yar at, secons at the copper supposed Convention Marynew thereign to the brake room water Witches Co, North Caronna at the Carton

gamese minerais in a ven of Buld Knob unat town of Galax. Alaghuny Co., North Carolina.

### MAGNETITE. - Magnetic Iron Ore.

Isometric. Most componly in ortalectrons, also in dedecate-trons with faces structed | edge between distoratedron and octahedron (hig. 745), in



dendrites between plates of mich, crystals sometimes highly modified, cubic forms rare. I wans to pl. o(111), some not as polysynthetic commang In peliar, producing striate ha on an octal piles, face and often a pseud severy age Fig 500 p 198, Massave with lammatod structure, granular, coarse

or fine; impalpable Cleavage not distinct, parting octahedral, often highly developed. Franture subconchords to uneven. Brittle H = 55-65 G = 5 168-5 180, crystals. Laster metalic and splendent to submetalic and rather dall Color fron-black Streak back. Upaque, but in this dendrites in mica

nearly transparent and pare brown to black. Strongly magnetic, cometimes

possessing polarity (lodestone)

491

Comp. FeFe<sub>7</sub>O<sub>4</sub> or FeO Fe<sub>2</sub>O<sub>4</sub> = Iron assignmented 69-0, iron protoxide 31.0 = 100° or, Ovegen 27 ti, iron 72.4 = 100. The ferrous iron sometimes replaced by inagressium, and rarely make, also sometimes contains thanium (up to 6 per cent  $1.O_1$ )

OXIDES.

biagnetite, when heated to 220° C in oxygen, changes to red boot, a thank, however, naticeable change in magnetism or Xray structure pattern, but when heated further to 550° C the structure changes to that of hemsiste and magnetism desap-

Var Ordensty — (a) In regulate (b) Maintee, with postudeclessings, and, granded course or fine. (c) his larger than it of fiction was burk earlies kind. Ordensty imagnet to a startation by a magnet but has no power of attracting particles of one model. The property of polarity which distinguishes the forestions is economical.

Magnetice 13 - 4 41 4 42, butter submotable, weak magnetic, in crystals from

Specia New Jersey and elsewhere

M. spanesson. Containing 3-8 to 6-3 per tent manganess Manganangactile From

Vester St. fberg. Sweam

Pyr, etc. BB very difficultly fundle. In OF losses its sufference on the magnet. With he fluxes resets we hematite. Soluble in hydrochloric and and solution reacts for both ferrous and terre upon

Diff. I date up ched from other members of the spinel group as also from genet by its bring attracted by the compact, as well as by its high size dir gravit. Frankhists a lattereste are only exhib magnetic if at all and have a brown or bracket brown streak also when magnete, by its black streak from bematite att. In contra, much harver than tetrahelicities.

And Alugnetite is frequently formed as a furnice product. It is easily formed in not finus imaginals when they are low in the percentage of solars. It is formed to the breaking lower of various among among among an processes among to

these of our last metamorphism

Obs. Magnetite a commonly found as a constituent of the crystalline rocks. It occurs where leaved test a grains in ignorial rocks, being found used all magnets in the ferromagnesses types in which at times it forms argue segregates indexes. Those committees there have been formed drough the processes of magnetic differentiation. They are deep higher dander and owing largely to an oriminative of droce or, and hen characteristic of the galdians and amount rocks. Magnetics bedoes are committee in the trebatal rocks, where they are frequently of great extent and owner us for the summer of stranges as these of beautiful Magnetic we assume last or metatorists rocks, whigh formed and we are the formed and we constitute the first amount time. Magnetic is commond. I do to have all formed and we constitue that the choical form at low temperatures and that later it may take on crysts are form. Magnetic as at regressive to most of the magnetic versely and to consider an extension. It is not formed an exception of the magnetic stranges are common it is a consequent at an inter-lake forms in the mean of many own and interest of corresponding that facts research as or own the strange of the an extension to be a common afternoon at the formed at of means own and afternoon the lands to the lands could treat a few and the formed at the strange of the lands to the formed at the lands of the countries at the lands could treat of beach as the lands countries to the same to the lands countries as the lands countries to the lands that the research is one countries to the countries as the lands countries as the lands countries of lands and a land lands as the lands countries to the same to the lands and the lands as the lands.

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trict Uml Mts., in sample and twopped ortahedrope in chlorite schist in the Zillertal, Typel towers and a he Pfiteshim Fronting formerly in Typel Italy at Tra smella in Posts at at M.e. Sommis, Verse is so the Ringer as Varios Switzer and 12 ages, Queens and American from Minus Center Brack. The most powerful and and inagnets

and a major the last Mite wo Lot the Board of Labor.

In the I makes States a signer to see many large beautiful the Agriculation of the Affirmonck region in New York requested in Warren beset and it ton in ten. The ores are in may leave in probabilities teaties need and only to make a near tending to here the in imperiod of the first and particle make the first the real fact bears and Mane, is been a first bear and the second of the control of the control of the second of the secon el mora de cic. In New ones at Hon, and and over Frank a, Sussex , a lead-H or I protect a series and red at arrival, later ment of the series a series break three in the large of the name, a section forms enclosed a major rem Property from Mingrow to we good Hot Springs, trikingage consists are as longur . a cristan o M . C. Thin, Min restals come for a horners, Cabic 

deep at or from Mages, who try any one of we the falls runs by finding, on taking his per a to mature that I so to do of the classes and the cron ferring of his start substree to the

EF altra.

An insportant ore floring

Magnematerive March rate MgFest, in octahedrana II = 0-H, Q = 4 fan a H Laster , can already our rangest to Strong magnetic Magneton errite and product of the arrivants meterlianean continuing water with pagment of and term I refer to the set of the month of the day the the net been the form No. . I say don't so and from mady. Occurs an Pay to be early on Mont Born. t y a long trunce

### FRANKLINITE.

Is a rice. Happy ortshedral edges often rounded and crystals passing

in the proof of grates. Massace grate is control or fine to compare

the thecles, age of the first at the true as it magnetic there are the conc lal to meeter Brile H = 5 05 (r = 107 522 Luster met as sometimes du Coder o re-basek. Streek reiblish brown or back. On an in except in thir time were to a = 2 the late olightly magnetic

Comp. It Zn Mr O Fe Mr ett, but varying ractor with a in the rel in on it are if the afferent metals present, while a forming to the

general form is of the spain group.

Progress Bli of it, a With hermy is Of gives a reast amorbigatine bond tra come an a life is been constant to grown area. Who sends give a look grown has been been a property of all and a rest are which are a broaten or and we have a will be a rest and a res with the following action and of other time

Def Is seen but on a first a first a righter attracted by the magnet and and a disclosure size at a result for the community of the first state of the community of the communit where the many that we shad you the district the district the first the firs here age to a few of or at the and a day we have by the few or the area. species to be for a fire at a set of the local to be use if these error away made more that a record of the established to while, to, or effects and notice the established in another than the property of the control of the

Use A need from Jacobsto Mgt Festi, Ma Festi Festi, Isometric adutoried octabedrona, Crysthis show evocasces of plage should synametry touchould free are, 11 = 6, (a =

OCIDES 493

4.75. Color deep black. Fowder durk rechrosop. Magnetic in Vernland, Sweden, at Incoleding in the Northwest laster and at Langton e. for at he Northwest Interest and at Langton e. for at he Northwest Interest and Linksop onnes in Orebro. Also from Debarsuca near Tatus Langton Bulgaria.

#### CHROMITE.

Isometric. In octahedrona. Commonly massive, fine granular to com-

pact.

Fracture uneven Britle H=55 G = 41 49 Laster submetable to metable. Color between front ack and by which black but sometimes yet owish red in very thin sections. Stresk brown. Fransaction opaque n=2.1. Sometimes for bly in great.

Comp. Feligo, or keetige, a Character sexpensate 680, and

protoxide 32.0 = 100

shows considerable variation in ron position and rarely conforms to the theoretical form do. The arctimate the replaced by a special mass be chromain by abandous and form from. The varieties containing but a trackromain (up to 10 per person are hardly more than variaties of space, and are closed under picotite, p. 488.

Pyra etc. BH in OF infanties in RF elightly pointed to be eatger and becomes a new or for term out of the base of the borner grant term out of the property companies to be presented to be a product of the property of the product of

Diff. This age often for a greate by feetile magnetic properties, stronk and by

Sie getheren. Biren ac ex was rho hie wage

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Half 15 (195)

Obs. George in period the mass and he segment me derived for a thirm, form as we so derived for measured it is not of the contraction of the measurement of the contraction of the contr

they me age beposits to being Misson issue Brown. Surveyon as Aprication from votice as American from March and March and March as March being as however the form the American from the control of the March and March

how extense is a red in New Sundiena

In the Later States is one to consider and in cryst is at It bears, New Jerres in set, at the said discrete in the Propose is one for a said Chester Copyand at Wood's line more found for set of the said in the Baltimore, in the more found for the service in an analysis of the said in the first interest in the first in the first in the first interest interest in the first interest in the first interest in the first interest interest in the first interest in the first interest interest in the first interest in the first interest interest interest interest in the first interest interest interest interest in the first interest inter

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smoothers. Maken on the stabellal crystals occurred to sand at Zelph Mt.

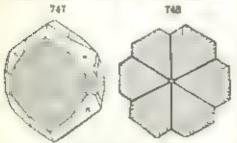
Serbin tand to have disposition for st

Tuzzontriz Not beed, Cour back with greenish tint Black streak Strongly magnetic  $\{1 - 5 - 1_2 = 5 \cdot 195\}$ 

# CURYSOBERYL. Cymophans.

Orthorhombic. Axes a . b : c = 0.4701 1 0.5800

Twins two plocation both contacts and penecution twins, often repeated and furning pseudo-exig on cristals with it with it recovered stigies 1 g 421, p 185 Crystus generally abount a 100 Face o stricted vertically, in fwine a



feather-use struction of ig 74%;

It is unterestant to note that there is a eliter at any members by a settle with stanta of chrysobery, and those of the qu gate he a senture of he was the set is as letter to be being about she as the same remaining

Cleavage: i(0t1) mutte distinct; b (10) imperfect a, 100 mere 4 Fracture uneven to concholdal His Oc H = 85 () = 15 (84)

Limiter vitaments. Color installing the green grass-green emoral legreen greenism while he is that given great ab broad vide months the negligity erical intraction to reserving the Street in shorted. Transparent to transactiff. Sometimes and an operator of case vancy, and asteriated Pleature, when he I = a discourage-vent w Z = c concentralegiven A (= a way columb ne-red. Optically + Ax pl. lettor, Bx ) a = 1.747  $\beta = 1.748$   $\gamma = 1.57$  2F = 84 43 Indices and axad angle variable, even in different portions of a single specimen-

I Ordens y I dor one green being colores by ton uses sides any transparent and then used as a gent.

A the term of his external green but could meeter by art some glid, varied to sign a residence of a register of the street of the str

d. fid. copy from gree salt a sale or big with hades and effect from the uni-

Comp. Bervill im adjantate, BcAgO<sub>4</sub> or Bett Al<sub>2</sub>O<sub>1</sub> = Alumina 80·2. glu true 10 6 at 100

Per ate. It is one mastered with sods, the suchare a mere's my loved dull Whereas remissions from a second to the second which the second which the second with colour which the second to t

first and rape to a transfer was a section of the

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the second general to the history and the second street and the se to ter bet our off man V v

Use the great mice see per Van above

Handmander M. A. of M. A. M. Cettinger of attable times and twelve Fig. 10. In the growth masses of training and the training and the state whose and the interpretate last record of the state of the s to ady ... - 2 to Lay Hamamanante to one of the am gamese numerals of primary

495 OTEDES

origin; it occurs commonly to veins associated with sold igneous rocks. Found at IIthomas, and near by at Orens, one or the round on held to the Harz Miss. In Vermond Sweden, at Librarian tends of his sounds from near Outo Press, Missa Corner,

Brandl, Oceans intimately mixed with peakers are in the national platent Arkansus.

Britarolite. Zinc hangmann to Zinc Mass., Tourne al Octanesira habit Perfect based compage Black Brown-touck areas to all a large 2 to 144. RB inter w two its as branchin. New Jersey, and at the World 11 = th to = 1 45

tone to be conflorate treat Lenavale, Columnto

Hollandste A mangamate of manga est barium and ferrie don Tetragonal Proposers to 1.1. Crystals up to 2 inches to each 1 line. Saces sent a strates, for a second like proposed faces having 1 a now. The sent a safety of the expensed line are not proposed and suggestion to also be a not better to a sacet a group. He are the control Proposed of India a line against the sacet a group and the Central Proposed of India a line against the sacet as forced of the line and the line and the line and the sacet as forced of the line and line and line are lines as the line and line and lines are lines as the line and lines are lines as the lines are where in the Chlar warsh harries are a the Nagratian Halaghast astrons the rived us a language had marganize to a had river settled the Atom Marchas the rest true and has seen allows he a more read to be and some published early error to the total rest of the form Romans to habite from leser ed as well red and moralise that they was the wasto on a surveyor of total the of a consent, a fire areal.

Cestrolite III Much la com as masses (che stem-gray II = 45 () =

Manum. Pt., or Photole Property as events as e 1, with Conserved red miners with phew wrenk oranges draw in = 24 Steamers procurate X = red-from Z = nearly counters. Of secondary origin, or the term is a he I represent the new dar in Barre from the heart in the second, from the Ar In he ! red & lest occurre a bah a to hat we had at he Jay come or West, if you have Blance Co and with pin therme and a north sour Change, Leading a Crednorite (at) Mr.O. Manahore in per lo-hexagenal plates, probates the

tes it of twinning. Perfect cleavage para by to take six covers open to H = 4.5. () = \$ 5.5 Lister detains t dur can but to stee gray is real bank, brownish from

Prostructions to Theoregia and the Montin Hose or neget

DE L'ESTE Cuit brets Rhombedwarat Crestion inbular parailel to bene to se ad the in seep bullet. H = 5.5 | Family findle for many magneto. So described and Color h. I stress successful features are I am M s. At the same and Are not up to Bushess Chebise Co. Arizonta with the complete are chap Alborna

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Verrolania, Sweden

Plumbulerrité Pho 21-50; Rhombal ceiras, trapezohedras i matale thick tale-Streak red like hema de Occurs with pacifistic of Jakotaberg, Normark, tit in Simus len

I security Size. ZnO 2Mn(5,2Hz). Soft and earthy. Chocolate color. Germy of

cavities in calemine are at Olkush, Russia.

#### BRAUNITE.

Tetragonal Axis c = 0.9922 Commonly in octahedrone nearly sometric in ringle (pp' 111 A 111 = 70° ? Also massive A ray study shows eight molecules to the unit cell.

Canvige p(111) perfect. Fraction uneven to aubroacho dal. Brittle H = 6 6 5. G = 475 482 Luster submetalic Color and streak, dark brownish black to steel-gray

Comp 3MnMnO, MnSiO, = Silica 100, manganese protoxide 117,

funagotiese sesquoxide #83 = 100

Although the above formula acrees cosety with the analysis, peobally a bet er way if express at the resilient of a to consider this is in xhire of the mountrybook inducation Muld O, and Musico, in proportions nearly 3. 1.

Pyr., etc. B B. infusible. With borax and salt of phosphorus gives an amethystics bend in C. F., becoming colorless a R. F. With some gives a bhash green head. Desort as in hydrochioric acol saving a residue of gelatinous sales. Marceline gelatinates with acide

Obs. Is commonly of secondary Lat may be of primary origin. Secure in venue traversing purphyry at Obremston near Limmon, Thuringia. Irom near lifeto Herr Mis. at 54 Marce Pasimust. At Langtonisi yeta, and eisewhere in Sovered. In its in occupa in paintific at Evaluarwaks, descript of Suggest, Certific Provinced. From Magnel Burnier agest Cute Preto, Mains Cornes, Brand. Marconne acterocade, from St. Marcel, Pindipout, a manze branchie.

# IV. Diorides, RO.

# Rutile Group. Tetragonal

Cassiterite 0.6723 $SnO_{\bullet}$ Rutile Titla 0.6442Polanite Min(). 0.6647 Plattnerite  $PbO_{c}$ 

The Ruth Chart includes the diox des of the elements on manganese, tituteum, and lead. These compounds crystanaze in the tetragenal system with closely sumfar singles and axial ratio furthermore in habit and method of twinning there is much some any between the two best known species me used here. Chemican's these uninerals are a metunes relasidered as as as as of Hour respective arms, as start, I met statemer. Sull Sull, for case tente and than, metalitabate, ( LO) lift, for rathe

Year, study above for cassiterie so about a structure to walch the to at the are arranger! in a fast, are, even telling a rat are. The passen atoms has a the same horizonta. plantes as in the atomic and are get you to pasts also benefit to atom. In the prince the pairs of avgen above have the direct in of one or the other of the prison hagorials and afternate in threaton in each successor, horizontal atomic ager. The other annohem if the group show closely similar structures.

With the liates ( n g is a seconstraint or ded a reen ZeOs ball - 0.6404 The ntumer element are in take but it is give up with the present at titles paint at the engineer of the estragon in one in the sales that the sales terminate visit in the sales the engineer of action a master at any the one are well the alread species that to, They said, it is tight?

the phosphase at the APO is a second at a crossed of any structure to this group. The same is true of so bute, My board and to be land ofth. It may be no sed that 2005, as the open or her one ite, crystallizes a the monocline

dyatom.

CASSITERITE. Tin-stone, The Ore.

Tetragonal. Axis c = 0.6723.

et, 101 A 011 = 1: 25 or", 101 ∧ (01 = 67° 30 ar), 111 ∧ (11 = 67° 30 HIS, 110 A 111 - 46' 27' ## 431 / 23 = 20 33] #', 111 A 111 = 68° 10 #', 111 A 111 = 87° 7'. ESTE, 321 A 321 - 61' 42'

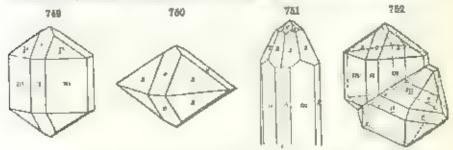
Twins common two plocifit both ceptaris and pepatratica-twins (Fig. 752, often repeated ( rystals I as grains a, also presente and nearly term nated. Serietaines very alender meedletin, Prem zone vermendy strated. For atomic structure see above tiften a remiorio shapes, strucure fibrous divergent, also massive, granular it impainable, in a fled grada

Cleavage at 100 imperfect > 111) more so millo harmy distinct Fracture subcenetion to the moven Britle H = 6-7 G = 6.8.7.1 Laster a lamantue, and crystals has by splendent. Come brown or black: sometimes red, gray, white, or velow bireak white, grayiah, brownish

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Nearly transparent to opaque. Uptically + Indices  $\omega = 19906$ ,  $\epsilon = 2.0934$ .

Var finding Re-stops In revelue and massive in situations and rail ated the fit betry in a and revolution shapes, on in the in situation and rail ated fitted a steam attribugh very compact with the rody to save of matter the less tooking commendations as a transfer search of the state of sand as it were about the term of a state of sand as it were about the beautiful result of an about the beautiful result of the constant of the same of the same



Comp. Tin diaxide,  $SnO_t = Oxygen 21.4$ , tin 78.6 = 100. A little Tasth at sometimes present, also  $Fe_5O_3$ 

Pyr., etc. Bit alone analtered. On charmold with such reduced to metallic tin, and given it were contag. With the fluxes sured are given reactions or non an immingation. On analthy action upon by at in. When fragments of consider to are mixed in or the involves in north contact with a little metal in an the exertence becomes contact with a bin gray deposit of metallic zing which becomes bright or for som.

Diff. Disting under by the bigh specific grants, burdiness, admithents, and by its yielding metalls on hill resembles notice voter to of garnet, aphalents are obtained builts. Specific gravity 6.5 higher than that if rist is 4, widers into mounts from a Ariff. Considerate by been arribants a property by the action of a proposal after apparent.

the termidore in a begind time at the other around rections at playing tented was to Obs. I wasterite is the cold are of the and in forme in many a beginning withough the important equal of legions are ear, and valve few in man or. It has been noted as an original contest and if the tenter to be I formed your relies to granted relies to grante each or pegual os. It has also been observed to puritar other pages of the cold and the second to puritar and the second to the cold and the second to puritar the cold in the cold and the cold of the granter are finely and to page at discrete any present at with the telling are have even shorted to make and topic at it was made present. The cold only a second to the cold of the present and topic at the cold of th

Large deposits of ver. In order occur in Corowa! Three were formerly very important but up to been largely exhausted. The Policiath sode over Redeath in tunin than 3 order ong in this been worked for more than 3001 set in activ. The constraint occurs often in the crystage and also as wood to and stock to. The more former witness is reported in the crystage of a largely calculation, the last to have Packageness for appropriate following the large in the continent of Europe unusual per mans are found at Schingger and Should the per largely and Approximate the continent of subject of the continent subject in the temperature of subject. Marienally and the temperature of subject, Marienally France. From Pitharants on Lake Lags in, business, are found at Vileder.

Important appoints could placers, occur on the Mains Pennanda and the neighboring bear is Procket and Bulton off he could defend the Case content and main price South Wales over an arm of 8500 square takes, fare crystals coming from Entravelle ( lending). Comb Eden) and Elemone, as in the New England Range. It also occurs to Victoria,

on Queensland and at Mt Bushoff Tamesma. From South West Africa. Important deposits sweet in Bolivia near La Paz, Cram, and Potosi with associated in orms of lead, shape and terminh. In Mexico from the states of Durango, Commenciate Amose etc.

Casestepte ones not wear in publity in the Luneri States. It is most commonly found in signal army rate to the pegunative voins. Since occurrences are found in New Lagand as at Norway Hebrar and essentiers in Oxford Co. Maine from New Hampstore, Managhasette, and Connect rat In Virginia, on Irish Creek, Rockbridge Co. with wolf rain e In North and worth arothen and Alabama. In South Dalmia near Harmey Peak and near Custer to ty in the Black Hole, where it has been mined. Low-grade imposite opening at Tunescal in the Santa Ara Me around flavorable Co., Cautornia. Mas also been maned in the York hetricy beward I'm amile. Alsaka.

Use The most majoritud ore of the

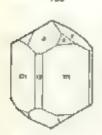
Palamite Mangature and Mats, Tetragonal Atomic structure similar to that of case tente, see y 100. In composite parallel groupsage of number crystal asso forming the order shell of creatale having the form of mangan re H = 0-65 G -4 952 Inster notation of older aght steel gran or iron-gray. Streak black. Definite and well crystal and probability of mand mix at the sen Blatne in Bohema, Cecchisoman a. having cen terived by the a crat is of anighr to. It is during ashed from perclusive by its hardress and as anhyarms character. Lice pytobaite it is often a pseudometeb aiter mangemete.

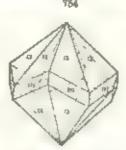
### RUTHLE.

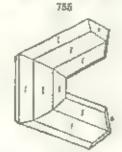
Tetragonal, Axis c = 0.64415.

Bon 310 A 3TO = 36" 54" 131 ∧ 111 = 58 25)\* 11 11 1 11 4 4 46 46 W, 313 4 20 6  $ec = 10 - 0.011 = 4^{\circ} - 2$ ee , 10, ^ 101 - 65° 341

Two a tw pi (1) c(10) of an generalisted (Figs 755, 756), also contacttwins of very varied hab the metions sixtings and eightangs. Fig. 425, p. 185, Fig. 439, p. 188) (2, p.301, rare contact-twins Fig. 44., p. 188, Crys.







tas commonly premistic vertically stricted or furrowed often slender accular Occasa only conspare trassite. For storic structure, see p. 490. 758



( eavings | 1 .00 at | m . (0) damm ., will m traces fract re scheonchechil to uneven Brittle. H = 6-63 to - 4 lb (2) also to 52 leater metalac-adamar tipe (cor redush hown passing into red, sometimes to lowish bland, volct, blick, rarely grass-green w transmitted ight deep red. Streak inde

brown Tronsparent t pager Optically + Refractive in lace high  $\omega=2.61.8$ ,  $\epsilon=2.0020$  Birelinggenos very high Source trees also ormally bear al-

Comp. Therefore decade  $\Gamma(0) = O_{XV} \text{gen } 40.0$ , titing 60.0 = 100. A little from is usually present, sometimes up to 10 per cent. While the from

499 CHIDES

present is often reported as ferric the probability is that in the unaltered

superal it existed to the ferrous state.

The fortunas for the le may were ter, as a tempt stationate (TiO TiO. With this the extrant trianner tribit; may be evaporated converiend and and so account it the rin free agents, present It has been a agent of that the tops I in modes do held IngO, in also country has and that tay a to believe to the same grown as rul a and mostlerite see american telew It has been a sed the rate an armere as occur and coate content shows by many to de an wear other shorter, not black G - 4 P-4 25 Trans-

parent quarts is sometimes per strates it say with near distinct or equilibrial presents. Durk smoots quarts penetrated with the sort, or value or with to marte," is the flicters I share the beat is have stone to me are crome a from more oil to provide providing on table ar crystals of he acte mee somewhat surery un bagger in Retained twin

groupe of shouler crystals are horsen as agreedy an also

from few as to the more than the section name, contains up of the contains of former than the section of the se the pater, no tate and tout date G = -4. Structure is the same instant with greater appearants of the tout date present of forces from the tout of the tout date present of forces from the tout of the tout date present. to any care of same to as submily and a ferrolen straine a fire is me true a shired facus for a the dament should White Germen, Brain, which is interested of T(O; with a little water

Pyra etc. BR abuilde With salt of phosphirus gaves a enformed ben la which an the security of the care of the first property of the contract of the security button of the bound at he is the a not only a positive after treatment of the box a the the sit all ofference and de security and to set the form in well at a part est a secretic ate. The edit is could be an excess of grad was the addition of the

gt ea a benut - vices our atre concernated

Diff barreterized by the ore dian a manuscription lister up t brown she red color her or from that is the very value to, and to being enturely unadered when healed in the b B. Spec pe grant about 1 - contempt 1 5.

Micro In this sections above red brown to ye low color very high renel and high

entries of appendictions of course

Artif R t e has seen former artific ally by heating things or de such hence on le sy, h sodium together etc. I also occupied site and much so have if some figural by brusing setases in a boundary for the charges are present on the torn and give the last of R. in a formed at the hast self-compared are, brusing and bluer ten person are und combination at the most of all the is of apparently the most product or of Total an cramming in b brench to and a produce have been build that his a special to ratio

Obs. He he are remain the enterior of the process works up to his I remain the opwhen the grantes has a latter as a present of a none what the conservers after all at example the number of free service see that the engle, our range as an extention of n as, men, the agreement report or on the form of more and regulation of there of a means of busing of the logical and fire in the manufact of whom prove toting purity I was use been ther wit is he at the and attenuity at a constant in grants of restal imagine is in many

Marcherough Residen ) to prove hypera to so all one man, often in microscopic cristale. Open me most produced formation or because a steel a steel a state of the state of the state of to a man is to see the two in at Rours is said of at Prigon to a filling to a fill of the said of the filling as of the filling as the fillin Le cons Years and che here la Freder at Sant Years to he Langue thate. South Australia. From Manas Garness It are

In the Lartest States out to see its in Vermitt at Waterbury. At various localities in Massach metal, Commentant and New Victo In Penning and a liberty of a Penning long New to and at Sails my was the algoring astrone of Law sets, the Important deposits be in Air herst and Netson com on Voreiton. It many ocal tion. North a arelina especial all acres Point American of in specimen ervecules contact in st. In Coorgin as Courses M. enterin Lancole Contral large and limited as a study with carallelein Askumens at Magnet Cove near Helby in ga

Figure ments of the dates after consections had favorage Companie and elsewhere in Switzer at S., rom M. agascar, Mines German, Brain. West matitoria, Vermont, Alexander Co., North Carolina.

Himengratide was original a formed in the littless Mrs. Russia, also noted from Ampsingabé neur Mandraryo Madagascar Siringede was originany described from Craveggia, Fled out from this also were found a Madagascar at Tongafeno se the of Betafo and at I from a sout he I to more Keystone, Pennaggion Co. South Dakota

Use. - A source of thenmm.

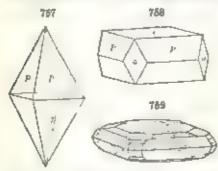
Platinerite. Les logor se PhOs Tetragonal Structure that of the Rutile Group, see p 420 Rarely in prismate crystain, is oid baselve. H = 5-5.5 (, = 8.5, Luster submetallic. Coor true : nek. Streak chestnut-trown. From Scotland at Leadthe Louark, not not by war exheat, Dumfries. Ask in Idaho at Millan Corur d'Alren district, and elsewhere is Specifique ( o mid in the Calmore district, Leith Co.

Baddeleyite. Zeron on June le ZrCh. Contains a se all amount of hefolum onde. In the late monocause crosses of a trage, 00. It = 6.5 ts = 5.5 to Courses to seem broad to the Optically a = 2.13, a = 3.10, y = 3.20, 2V = 30°. At ps = 0.10 to axis = +1.1 The process, strong, a > a broad cyling from Brax near Culdus Minney Courses and Jacopurango. São Paulo brandes. From near A. 16. Vesurtierron, I sweden Nied a Mie Some in You view Ale and Borman, Mastern. for a because on the of them consent of rearly pure Late, others of nearly pure ZrOs, while others are various phosphates.

### OCTAHEDRITE, Annies.

Tetragonal. Axis c = 1.7771.

Commonly octahedral in habit, rether weate (p. 111), or obtuse (c. 117); also ta man, c 001 predominating, rarriv prismatic crystals frequently highly in shifted. X-ray manyais shows did the Triatons he on a shigh by



deformed diamond lattice (see p. 40). with the O atoms arranged in pairs on catter mde of the II atoms in vertical lines.

> \*\* , 01 ^ 011 = 76° 8 \*\* ,01 ^ 01 = 121° 16 \*\* ,11 ^ 111 = 82° 9 111 / TTI = (36° 76) PP. 113 A T.3 = 54 1 or, 117 A T 7 = 27' 39

Cleavage c(001) and p(111) perfeet Fracture subconthoutal Brit-H = 55-6. G = 382395, some mes 4 H 4 H after heating

Laster a lamant ne or metallic-adament ne Color various stades of brown. passing out and go-blue, and thack, greenah yellow by transmitted light Struck and ored. Transporent to nearly paque Optically - Barefrangence rather high lardices  $\omega = 2.534.2.564$ ,  $\epsilon = 2.488.2.497$ , varying prebably with rea content. Sometimes abnormally biaxed

Como. T aman diox de Tith = Oxygen 40.0, hinnum 60.0 = 100.

Commonly contains smal, amounts of man oxide

Pyr., etc. - Same as for cuttle

Artif. - See under cuttle.

Oha. I was a of secondary crigin, derived from the alteration of other literaturebearing nanorals. Occurs is grante quarte surple by groups, chlorice and rates settings. Switzerned in the language. You am, the variety exercise long numbered to be renoting at average, has Invested, the language of floury. d'Channe, Indre, Prance, associated with feldspur, amute, and simenste. In chierte near

oxides 501

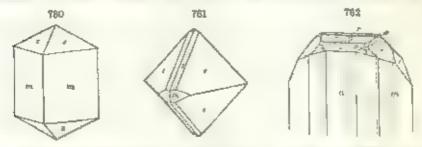
Excitately, Decembling. In Manus Gerare, Brazi, is ephendent creates in quarte. In the latest status octahedrite has been found in Manus a certas at context fire. From Magnet towe out if he being an Aranana. If is or state at he large to her of planes are reaching a central setter in diameter have been found on occaver a read, to annion Co., Colorado.

### BROOKITE.

Orthorhombie Axes a b,  $c = 0.8416 \cdot 1 \cdot 0.9444$ 

Only to crystals of varied babit. Atomic structure is similar to that of columbite, set p. 695.

General model indestinct, c(001) at least the fracture subsequent and to answer Britis H=5.5.6  $G=3.67\pm0.5$  Luster metric



be-neumantine to a breatable. Color latt-brown vall wish reducts, reddish prown, and transment and brown to trop-black, apaque. Strenk uncellered to grayesh or yellowish  $\alpha=2.583,2.584,\ \beta=2.585,2.586,\ \gamma=2.745,$  aptroady + Bx always 1 (100) Ax pl II (10) for bl e and green agr. (100) for red and we kin light. I max all for a yellowing green color. Surong dispersion. All second interference figure. See p. 3.26.

Comp. - Titament a hoxide, Trek = chaygen 400, treatment 600 = 100

Prt - Name as for mit at Artif See ander notice

One in agency of right, and assert altone brook to as on an its ordales mis. Four it in the good absence is the limit that at I is something as I four the every superior of any last on the form one beganning at the line last of the four transfer of the four tra

In the I hater. States from I of Settouvil a Manufal met a a Thomas a larger of New York, on parties with challengaring on a galaxies and attended of crystals of knowledges.

at Magnet Construct It in things Attained.

Named after the Empanti Communication of J. Brooke, 1771-18, 7

#### PYROLUSITE.

Orthorhombie, but pseudom rphous, comments after mangamite. X this study shows that pyrocuste has the sum of more struct to as principally which is apparently the day drysta me from of Mrth. I sum a columnar often divergent also gratular massive and frequently in remain const.

Set often so ing the fugers H = 2.25. G + 47, 186 I reter metade. Color con-block, data steel-gray, concounts black. Streak back

or blush brack, sometimes submetallic. Opaque.

Comp. - Manganese tioxide. MnO<sub>5</sub>, like pulsante (p. 498). Community contains a little water 12 per cent

Pri, sto. Like pointable but most varieties yield some water in the closed tiller. Duff the reasons have the most varieties yield some water in the closed tiller. Of all the reasons have the most in the reasons have the most in the reasons have the reasons have a contract of the reasons have the most interpretable to the most interpretable the most interpretable to the most interpretable the most interpretable to the most interpre

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## B. Hyproca Oxmes

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that when the produced grap is the Beaute Choice there are the

that to come species of pore Mg Off and Pyrights to Mr Office

By the tale to and Pyronurite. But II , are use related and further Hydrotale to and Pyronurite.

Diaspore Group. ReachH, or Reach H.O. Omby show he

Diaspore		q	h e [
	ALC: HO	0.9372	1 0 60 th or 0 6443
Goethite	FC O. H (2)	0.9 85	THE RESIDENCE CONTRACTOR
Manganito	Mag02.11 0	0.8441	1 0 5448 or 0 6463
DIASPORE.			

Grands where Ares a  $b = 19372 \pm 0.6000$  for stall prisonality, mm "  $100 \times 11$ , =  $86^{\circ}$  17 term by the plattered  $b \approx 0.000$  sometimes secondar. Also formated transmit and in this scales is the times stall or the

Cleavage b 010 emment, h 210 less perfect Fracture conchoidal, very bracke H = 65.7 (1 = 33.45 Luster Franch), pearly of meavwestage, elsewhere vitreous. Color whitish, gravish waite green sh grav. nor-brown, verywish, to coursess. At times plenet rose X = dark verst or read niws, Z = fain years. Transparent to subtrains cent objected \* Sirefrescence high Ax of b = 0.00 Bx a = 100 This person a = 100 Compared to a = 100 Bx a = 100 Compared to a = 100 Bx a = 100 Compared to a = 100 Compared t

Comp. AlO OH or \$20, \$150 \* Alamana 850, water 150 = 100

Pvr. etc. In the closed to structure is not generalize struction permuting into white pears water at at a by reason are an activities at an go was or at My 3 to be that

The agreehest be to hardness on t pearly rates also It It his to decrepated on and in the new or the contract of appropriate with relate to appear through one in the

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at your will committee and intergrate at Newson new consecute chance to.

2 enneyty some

No a to Harry from deservings to center all along to the usual descriptions before

for my Probable M.O. Rat. Comp deduced from managery of X-ray pattern to the majoritant of a state I am angle 63" most man brought to did by a state I mer alignery higher than for gibble to

Found in the beaution of Artest and Ant France M. to one. Microsome electrons if the first and the first and the first and the state of the first and the fi 1.4 Ann sight argo as a finere and right form of common creature from the red Annual ring as A by or as a find as to be sent presented for our to those of anywernes from the Escatermentar mining estrict, it uses, one begin tution transferate.

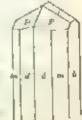
#### GGETHITE.

Orthorhomitic Axes a b r c = 0.9185 | 0.6068

Pr. 131 1 111 - 58 481 com , 10 lie = 85 % ce , 0,1 ol1 = 62 30 pp , 11. " 111 - 33" 42

to prisms vertically strinted and often flattened into scales or tables a bitt. Also in rouse folia od or to senses mosfive reinform and stalketitic with conceptive and radiated etructure

Cleavage 5,010) very perfect. Fracture uneven Brittle H = 5 5 5 G = 4 28 Luster imperfect adams nine Coler yellowish reddish, and plackish brown. Uften blood-ted by transmitted light Strenk browniah yell-w to ocher-yellow Optically - Optical axes strongly dispersed. Hx = (010) for all colors. Lx pl for red = (100),



for yellow = (001  $\alpha = 2.26$   $\beta = 2.39$   $\gamma = 2.4$  Only weakly peochros.

Var for the war a or about occasion and a officient to one origin to a the property of the state of th spends of Principal Barrior of the Kin the the court and the state of

Comp. For II a back Hall a Oxyger 270 mm 629 water 104 m 100 or 1m / steep 150 to 50 9 was er at , = 00

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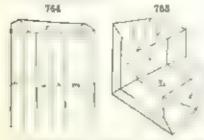
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Legaloctocy e V 2 or 10 m f sub or 20 m and 1 for a for a for a for a formation of the formation of the

rtogr to the first process of an or H monitor at transfer to Tula, Regards.

## MANGANITE



Orthorhombie. Ages . 6 0 8441 : 1 : D-5448

> .. 134 4 1.8 1 2 2 -011 V 011 - \$1. 10. 113

That to come only that the the In a feet attended with my of the ETT I AM IT IN THE TREE THE PARTY ent has not at absentite

Clarence built with perfor at the party to beggin thereof Britis II = 1 4, " to 11 Laster admictache I mer dark stee

505 OKIDES

gray to iron-black. Streak reddish brown, sometimes nearly black. Opaque, th minute spanters sometimes brown by transmitted light

Comp. MaOatH or MayO, HoO = Oxygen 27.3 manganese 62.4.

water 10 3 = 100, or Manganese sesquentide 89 7, water 10 3 = 100

Pyr., atc. In the closed take yields water manganess reactions with the fluxes, p. 371 Obs. Mangan to is associated with the other manganese or ass and has a second origin It frequency a ters to probleme For his offen in veins assect and with the ne igner is rocks, faith as filling on these and as a replacement of the neighboring rock. Besite and calcite are frequent amountes.

chegars of veins traverning a porphyry at Dfeat Hars Mits at Jonesian in Thorning a. from Harbsonen in Rhammand Found at Bulet agar Undering Optergational, aweden In Carowall, as various piaces, occurring creatuaged at the Isomolaca rane, at Just Also at Execution, Compercated, at Freter, Devon, and from Gramma near Towie Averdean.

Sout and

In the Lake Superior from hearry as the Jackson mine, Negaunee, Michigan, and else-

where In Nova Scotta at Britgeride, Picton Co in Hautet of

Crystals having the comment in of manger to but so wing a sphenoidal habit have been found at Langtoniahyttsis. Verman I, Sweden, and have been called aphenomaniguante. Use. An are of management

### LIMONITE. Brown Hemstate

Not ervitalized. Am negal or load. Usually in state title and hotzvoidal. or manuscribary forms, having a birous or subfibrious sequeture. Has concre-

tionary massive, and occasionally earths.

H=5-5.5 G=3.6-4.0 I man also, often submetal c some mass dul, and earthy. Color of our see of tracture various since soft brown commonly dark and none bright sometimes with a nearly back , might ke extense yet at properly with earthy, browness yellow, schor yellow Streak yedowich brown tipaque

Var - 11 Compact. Schooled a to a few to later often standed to factor follows "I thehream or earth of which of the more of the first of the reserve of the set from our figures government when it is not been been recommended to the set of the s BINASER of etc. in concre novato a naples

Comp. - Approximately 2Fest; 3Hst) = Oxygen 25.7 ccm 59.8 water 115 = 100 or from sesquestes \$55, water 145 = 100. The season or, tout varies willest that the facility of that have not seed for all to give moder and track be consilered as the court cas form it goethire with elserbed as a capitary water In he tag oors and others send that It is not a out or of thought arse, un't hattie or other coarsed organic right are ery coannell appointes.

Pyri, etc. Take ma have being a true to trace a succession about in its he sail of

Dell destruction on a large processor of a processo figure er where there was on a tell to a logic of the tenutes and while w

and surface over water

But such a course was explained from an any original franching for a five after two their costs, at a course to course any original franching for a five and original franching for a five and an analysis of the agency of the same of the agency of the agen above because the startest new equals of the organic to be an of the to be enspoysten of the carbonic acid in the water is one cause in this separation of the irin

cuide. The arrangement also saled by the so-called from hasteria" which also the aron from the waler at least are so as ferror to trouble famous to consequently condown and to beprete ment and a to a search a see short the or made too more tert is the most has been about the my distriction on the left of the week on a at Latinovite turner times and a great greater, it in half of many metallic verse. It is dien unto-Edition with the na one one

the I is its of the series with in large qualities in Lorrance and Laxent song and mount for the rest my last me are in with it is the Lawrence was a mon-Haven's the Isra has an order or South of the water they are made in the rate non-trende of the contract as we bright the glass free bosins as a The best of the second of the

Ca arr senz Brat. I

I sound on the United States and on small deposits and of little reconstruct value Fisher to their the grant and a man and here I all the process of the controller are to have brook an elementar are in the over an Herhalt on Co. Master de a Cher es le san com má in Pennas canal large per dethe the after parter as some them to a laborator and south thick that the Market of the teacher are an entire or the teacher and the teacher are the teacher are the teacher are the teacher and the teacher are the teacher a the frales were taken a hora was

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In the lister is on a good real absorbant you sage with relations at the hours to or test disable in the contract of the amounted

masses. Found is Pennsy varie at Chestnit Hit Laurister to

#### BAULITE Beautite

In round concretionary disceminated grains. Also massive, coling and earthy, clay ske for = 2.55. Color who ash graytch, to other-velow. brown, and red  $n = 1.35 \pm 61$ .

Var - 1. In concretionary grams, or obline, fourty ? Our as unchrough the pareer kind grayab, clay have containing very wife one once was red from the mon ducto present.

Comp. Essentially Al-O<sub>3</sub> 2H-O - Alumina 73.9, water 26.1 = 100 some analyses, however give MAA Hall are commore.

Baugite is profes to a matter of marking character out containing large amounts of a colloudal furen of the sulpt. The relationer has seen carried a segrent of no per youte distrible and assessed

from semparate of unitally present named man in large amount in part replacing oldratio to one one are a pointy. The name homely or has been suggested for this contained from if error ratio. Sames, phosphoric and, earliers or I. I use magnesia are

Obs. He is in a discondary origin and has constantly been broad or let troposal climatic end I was by the prolonged weathering if a r , it bearing rocks. In come becaution it has case appracently been fer yes, our she are turing if his worting the steady. He is a discrement of the property of the state o It was the province of comme perhaps agrees the second rate or and to and from the green a have had in the private and a come in the street a conat the base was a construction of the original state to preserve where the base of the property and depend on the base of the property of the same of the foreign of the base demonstrates the reason of abuttanian as a sere has a a track of mange or less tree of a. are for all or the real and marks. They are known to a new Hower are to be to the the party of the party of the property beautiful and the contract of the contr as twee stagemen that during the literation is attended affect a cartier on a a have actes then the a were it a makes with the furnament of as all one or artemate, which, because the details harmon has broken down and smed business to gifteen Tataboon.

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Laurence are some to India, on Seychoole faland in the Indian Occur, on Madagascar

in French Galana, etc.

Use. — As an eluminum ore.

# Brucite Group. R.OH)2. Rhombohedral

BRUCITE.

Rhombohedral Axis c = 1.5208 or  $0001 \land 1011 = 60^{\circ} 203'$  or  $1011 \land$ 1101 = 97 371' Yeary study shows a structure in which the Mg and O alone are arouged in conzontal planes in which they make bedge tist patterns. These a record planes are grouped into sets of three the central plane contribing the Mg atoms while the O atoms be to the planes above and below. These groups of three structure planes are widery spaced from each other, thus accounting for the basal neavage

Crystals asnudy broad tabular. Also commonly foliated massive fibrous.

fibers separable and clastic

II = 25 (, = 2 8-24 Cleavage c 0001 en acrt Felia separable and fexible nearly as in gypsum. Seetile Luster c pearly, costuhere waxs to sitreous. Color white inclining to gray hote or green. Transparent to transpreent ()prienty + [mlees \( \alpha = 1.5617, \( \alpha = 1.5615, \( \alpha \)] Birefringence varies for different colors giving rise to an unusual succession of cours in the rings of the interference figure. I brous varieties show harmal

Comp. - Magnesium hydroxide, Mg (iH), or Mg(iH)() = Magnesia 69 0, water 31 0 = 100 Iron and manganese protoxide are some times present

theleson, negarity in plates, white to take growth to court strong peaks luster on the converge surface. Nessaltic as a filtrons variety con saming 4 to 5 per cent gran protonne, with C = 2.44 Musique transfer contains manganese: occurs granular; color

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Names our best there or near and A Brown terminal. Sweeth.

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Bicketromite Present methy to Mangabese badreaute Mart R., Orthorhom-tue Present Research from Linguistics, Formant, worders in additionate Appropriation with parameters

### GIBBSITE HA Track mile.

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fren a faint throng a met in a hin

there are c (01) entered. Thugh H=25-35 G=23.24(a) rich c, gravel green shor rathern where I ster of Wil pearly, d other faces vitreous of star on of starger tes than I have goonly sometimes transperent in the action of the very + 21 dw vs and and may or 0° In last 1 554 1 589 Av pt user by 1 010; at temperatures above 27° ( ber man and 21 here we will may of temperature being 0 at 27° C A strong antillacer as so or a bit for see, on

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water 34.6 = 100.

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Sunstantaire & or juncture Alath Aligh Amorphism, Immaparent material found

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F and a, along same young, Verminge, Sweden, in him one asserted with mostly and lante

### PSILOMRLANE.

Massive and horryoidal penform stablet c R = 5.7 G = 1.5 4" Justee soft metrice dall respect to write, back, shinging to or in ablack, passing a ite slark speesgray. Opaque

Comp. - A manganese oxide containing vary ig actionnts of Lipum, petassium and social ox les and water. To be regarded us or below Math with various neser and importions

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Roy, Man and it conserts many of made of mangatime and water with some oxide of

trop, and often silica as ma anta

Set with  $r_2$  for the  $r_3$  Hard Continuous Constant Samuellary Color and stronk that Burt prof. H = 45 G = 1137 Possibly the crystalling equivalent of the same a between the X-ray study access greature structure. From Mandaga. haranga lady as trace also at madein stee Landto Course

IL LEADER TE APER E PERSONAL CONTRACTOR OF PERSONAL OF PERSONAL OF PERSONAL PROPERTY OF THE PERS form classes. I and at Somethern San av also than Witte bear Raden, as an alteration the state of the state of a second of a second of a second second of the company to Car Car Car . "Hat has two found at threath in hattage, Belgian the bar a to malachite and thrysocoals. All three are probably colloids withour effecte o dupoer a fa-

transitive, or Earth, Cobell, contains oncie of cobalt, which amortimes amounts to

debatovers. Contains copper iron and manganese oxides.

Law, at the or Care and Manguerer, is a wast untaining the 18 per cent of ende of entiper halt of es in to all cohes, also

LUBECETT IS a mixture of copper, collect and manganese oxides.

SERVICETTE BLOWS Fred & Hell Color black Street lack brown H = \$55-6. For a to magnet a garbane. A terration product of pyrormingue. From Iva, Anderson Co Samb Carang

14 c n. ez. 6Mmg/l. Fey(1, 8Hg) Lauter patchy Color black From Beldongri, Dietrict Visgpur, Central Provinces, ondia.

Sassolite — Born and BOH. The become in pseudo-bermonal plates, tabular to the larger small, white party mass featest basel as use optionly — "I very small of 1 100 5 - 1 to y = 1 to Bian dealty. Ut it = 3 to 145 bery cast (white bound a the roses of certain languages and in the waters of hot springs were saided to as meaning a a. The regular's are of the bone and a m fer to a content of talk in the waters of the medical influence between V il berry and V and V extreme first and a the was found then a become the traditions non-house of Creaseto, Suscepty where are said as almost the in the center of Videntic, Latinet Intrasper.

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fanthunde Perhaps 25 (t. 711,6) Orthorhombic Account crystals. Michigans class age. 100 ( for years-black altering to regar to reman Stream browns valed to a large of the stream of the st

year to and schoopste at hasolo, beignes t ours

# VI. OXYGEN-SALTS

The Sorth Class includes the saits of the various oxygen scale. These fad into the following seven sections | 1 arismstes 2 Sugates and Tranaics. 3 Nousies and Inntances & Phrispianes, Arsenaics, etc., also the Nitrates 5. Borates and Uranates, 6. Sulphates, Chromates and Tellurates, 7. Tungstates and Molybdates.

### 1. CARBONATES

# A. Anhydrous Carbonates

The Anhydrous Carbonates include two distinct isomorphous groups, the Caratre Group and the Aragonera Group. The include thements present in the former are calcium, magnessium from marganese, zine, and cobait, in the latter, they are carefully barrum, strongton, and read

The species included are as follows

1. Calcite Gr	oup. RCO.	Rhombohedral
---------------	-----------	--------------

		77	E
Calcite	CaCO,	74 55'	0.8543
Dolomite	CaCO, MgCO, Tri-rhombohedral	73° 45	0.8322
Ankerite	$C_8CO_4$ , $Mg_sFe_3CO_4$	73" 48"	0.8333
Magnesite	$MgCO_{\epsilon}$	72° 36	0.8112
Sidente	FeCO <sub>b</sub>	734 07	t \$184
Rhodochrosite	MnCO <sub>2</sub>	73° 0'	0.8184
Smithsonite	Zn( () <sub>1</sub>	72° 20'	0.8063
Sphærocobaltite	CoCO <sub>0</sub>		

This has gives only the proposent species of this group: the names are of the monurphone intermediate compounds will be found under the description of the different members.

The Calcute Gaour is characterized by rhombohedral crystallization. All the species show, when distinctly crystallized, perfect rhombohedral cleavage, the angle varying from 75° (and 106°, in calcute to 73° and 107°, in giderite. This is exhibited in the table above. For the atomic struct ire of carete as shown by X-ray study see p. 41. Similar at dies for the effect members of the group show the same type of structure for them all. Sincerite and rhindochrosite have almost identical structures thus explaining the complete miscibility of these two molecules, while in the case of calcute and magnesiate the dimensions of the unit cell differ one ugh to explain their very limited miscibility.

2	. Aragomis croap	a ROOM	Ordinamento
Aragonite Bromlite	CaCO <sub>1</sub> (Ca,Ba)CO <sub>1</sub>	63° 45'	0.6224 . 1 . 0.7206

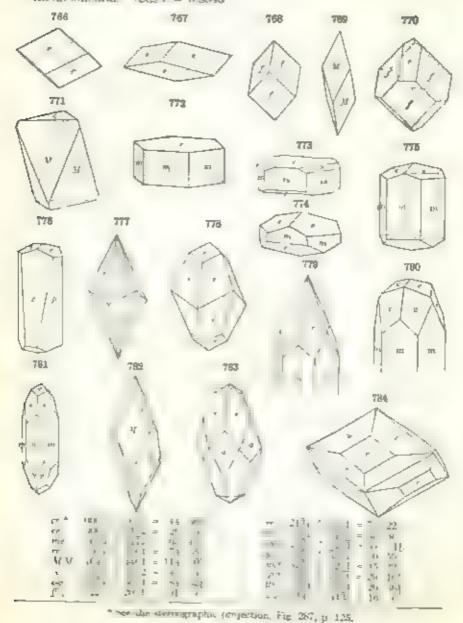
DCO. Outkookombaa

Witherite BaCO<sub>4</sub> 62° 12′ 0.6032 : 1 · 0.7302 Strontianite SrCO<sub>5</sub> 62° 41′ 0.6090 1 0.7239 Cerussite PbCO<sub>6</sub> 62° 46′ 0.0100 . 1 0.7230

The species of the Aragonita Guour crystallize in the orthorhombic system, but the relation to those of the Unicite Group is made more close by the fact that the passinate angle varies only a few legress from 60° (and 120°) and the twinned forms with the fundamental prism as twinning-plane are pseudo-hexagonal in character. A-ray study shows a complex structure which is archorhombic but nearly hexagonal in character. The different molecules of the group replace each other to a certain degree but to a much less extent than in the Causte Group.

1. Calcite Group. RCO: Rhombohedral

CALCITE. Care Spar Calculations Spar Rh rabbohedral. Aggs c = 0.8543



Habit of crystals very varied, as shown in the figures, from obtuse to acute thembolisdical from their todaylar to Long prism and and scale models to of many types, often legisly medified. Create crystals extend a greater variety of terms and but its company other material.

Twins see Figs 445-452 p 1887. (1 Tw pl cf0001), common the crystals having the same vertices axis 2) Tw pl coll2), very common, the

vertical axes in lined .27, 203, and 52° bos, often producing twinting lamelies as a Toeland Spir, which are in many cases, if secondary origin as a grant or linest new Log 1850 (bus (winning may be produced artificially see p. 215). (3° Tw. pl. r.1011), not common, he vertical axes inclined 90, 46, and 80, 44, 4° Tw. pl. ft0221 from the axes of tersect at angles of 53, 46° and 126° 14°.

Also femals with the new and fine, sometimes lameliar of the graduant from coarse to imparent to and compact to earthy. Also statistical telepose, neclassic and other unitative forms.

classings will be a specifical Parameter 12 determined by the control 12 determined by 12 determined with difficulty 12 determined 13 determined by 13 determined 13 determined



785

Section of creme to drie

with the direct of a the cleavage face, early a limb select G = 2.710, in plan existing, but varying somewhat widely in impute there as in the containing from manageness are limiter vitreous to subvitations to a ray Color white or color as a recovering pale alorses of gray, red, green bine, videt, videx also be an and limit when any are Street which is grayed. In apparel, a spage Copian varieties show phospherescence upon hearing and others hammescence upon being exposed to sublight of real an estimation.

Out only Brefringence very ligh Refrictive to bees for the Letine a = 1 tiph 0,  $\epsilon = 1 \text{ 4862}$ . Sometimes the reliable with  $w = 2\lambda$  varying up to  $a = 2\lambda$  probably due to a molecular strum. For effect has been produced artificially

Comp - Che am eighorate Cattly = Carlon down to 414 one 56 of = 130 Sm d countries of magnesian, non, my games, and, and call may

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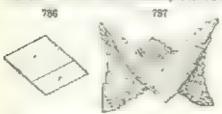
# DOLOMITE. Pearl Spar pt.

Tri-rhombohedrai Axes c = 0.8322

$$\sigma'$$
,  $1011 \wedge 1101 = 73° 45°$ 

VW 4041 ^ 710) = 112° 53°

Habit rhombohedral up ally a 1071) or W 4071 to presence of rhomhobodrous if the see for tard series after the phonon of you very characteror ic. The faces commonly curved or more up of sub-radiving spand this



passing into end descaped forms Fr 787, I wroning on (0001 or 1.0 1. Somet mes ahows polysynthetic twinning, tw. pl. (0231). Xtay study allows a crest il symmetry lowers is the tof carry. A replacement of one-third of the Mg atoms to be loss jut change the character of the structure

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Charge r love protect brackets a remaker of Britle H = 3.5-1 () = 25.29 Letter very mething to pearly in serve early er to Court with a redd at the greenest with the research green brown gray and last Trep and to transactor of only - 2 = 108,74 e 150,50. Let us, ces and barefringen's increase with more se of fron or manganese

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#### MAGNESTER

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the gr . I purfect beautipe flat cor Lated Brank H = 1 1 1 1 = 11 13 erat There there may be the Such four white, yelowish, or grayish white, brown I rancorrent to opaque. Optically -  $\omega = 1.717$   $\epsilon = 1.515$ . Indices and birefringence the prace with an most of Fel to present

Comp. Magnestim carb nate, Mg(1), - Carbon dionde 524, mag-

nesso 47.6 = 100 Iron carbonate as often present

lances compagets between magnetic and adente have been described one below. made and the left is a the to see the for a contract of the figure of the thought the sers is not east as definite compounds. The following constitution has been sug-

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If I want to the whole a null to per out hely .

Sucrements with 70 to 95 per aunt Fet .

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Obs. Manager rage man in cut, and y to be from the asternation I come not up transports to the glotter action of nature costs of customs acres to be successful. for each of reduced terms of the rear of agriculture in phase per alternative of agree of the result of an expectation of the regard of the regard of the result of a consistent of the result of a consistent of the regard of the result of a consistent of a consistent of the result of a consistent of a consistent of the result of a consistent of the result of the re Magneton the trees as a pre-

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the I committee of magnesses that he shall not a section of reports therein. an time same set or - amount that the same speciment on the A. Bragamenta, e.m.

# SIDERITE. Chalybrie, Spathie Iron

Rhombohedral. Axis o = 0.8184

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	10.0				37.37	104	4.1	-	1	4
	r II II a						4 1	-	E	4)
VI,	10101	(BSC)	- 1	42 Di	-1.	lho	Set on 1	4	1,4	74

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Chavage will perfect. I'v mang a man, eften in laneau brac-

ture uneven or subconchardal Brittle H = 3.5.4 G = 3.83.3.89 Laster's treater inc. ing to pearly Color ashigns and wish gray greenish gray axes become and brownish red, rarely green, and sometimes while Sinck while Transport to subtranslaterat. Optionly = 4 = 1.874 and 1863. In lines and birefringence decrease as from a replaced by magnessian in manginese.

Comp. In a protocarbonate FeCO<sub>5</sub> = Carbon double 37.8 upon protoxide 62.1 = 100. Fe = 48.2 per cent Manganese may be present as in

stigonile manganoephenie, and ungnessum and carrielle

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Pyre etc. he have no is equivare growth and a life incommon transmeter. With his known as a form a of fill. With the fill representation is a minimal as a potential to the property of the

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of the North North Comment of the North State of the Stat

Use An orthogonal

# RHODOCHROSITE. Dialoglie.

It inhobistics. Again a 0.8184 of [C] a [[0] a 73° 0' District cris in a court of a solar the charlester of a colling a court with restricted straightforward from the analysis of a grant of a second correct. Assign to unusual butryound, with continuous structure, sometimen indicated, incrusting.

Cleavage r(1011) perfect Fracture uneven Brittle H = 3.5.45. G = 3.45.3.60 and higher Luster vitreous inclining to pearly Color shades of rose-red, yellowish gray, favor-colored, dark rest, brown Streak while Translucent to subtract usent process =  $\mu$  = 1.820  $\mu$  = 1.600. In boos and birefringence increase with increase in percentages of trop

Comp. - Manganese producation of Mr(1), a Carteen Gravite 353, manganese protein le 6, 7 = 100 cron carlsmate a usually present even up to to per cent, as a manganese protein the quoteens of rhad a browne and siderite are apparently completely misches see p. 5,9 and they may crystal are together in all proports as sometimes he carbonate of calcium, as in manganesiste, also magnesis in, and an irrarly cobalt

Pur etc. Bill changes to gras I sown and black, and decrep takes strongly, but is in a lie. With each of many risk is writer will give in anise I stronger end head, in bit becomes considers. With we are First subground Passelves with effect exception a warra I be because as I be exposure to the air changes to brown, and we are right rise-rest cares seems a just an experience to the ear changes to brown, and

Diff Characterized y par pank roles, rhombobedras form and cleavage, effervescence

in ar is.

Obs. Rhadochments a similar to order our to origin and mode of occurrence. It has been to sed in beposite that the second of more, and a meta-complicated badies that have been sensed for it seed, as a badie, if we compare our are as a gauge present of the many right to very to some experiency assessment with a very lead, and copper one and

with other mangagest conternia

So need the most section is a construction of chodochromic are given below. In Humania at Negli Sg and Kasin abanca and from arrows and the the foreferous asserts, wester than one at breaking in I come to prove at 11 most over order over the unit to be accusted at a section at region. Western in Interpret the forest of the forest of the first over the construction of the first over the fi

at temporary as began see that a still not be the time of the property at the Tark to a local to a standard restaurant of the store means and the standard of the store that a standard the standard of the store that as the standard of the store that as the standard of the store that as the standard of the store that are the standard of the standar

LAUST TE SPECIE

Numera rhodocurosite from poles, a ruse, and guanti color and dialogile from leakers, doubt

Use. A numer ore of mangaziese

SMITHSONITE Chambre pt Drawlope ore Minera

Rh mbohodral Axis c = 0.8083 ref 1011 \* (101 = 72° 20' Rarely well create fixed faces of 1011 generally crove and rough Usually remform betryoulse create with an tip rest the print, thus, man grandum,

and of less of these ally a secretary as a contract of the less of

there is a perfectly form of the state of th

Comp. Zero earborate Zef O<sub>5</sub> = f arbs a dox) is 352, and protoco is 64.5 × 100. Iron redsonate scatter present (as in monherone absolution mess and cobalt carts area further carried and magnesium randomates in

traces, rarely cadminin and indigin-

Pyracts. In the same take here earlier for sole and direct in selfow with hot are some an earlier in the same and the same

coats the coal with the oxide, which is velow which in and white on cooling. This ordina, moster as without his income gives a great of air after nearing and it. Solving in the rochours and will off rich my

Diff In appraished from countings, which it often closely resembles, by to effert the

CETHER 14 /5

Obs. In a beautie is found both in veins and beas, especially in company well galetin unly werte us who exact nationed that was reference production to cos spendanta to destrement or fracta and same as one kinds. as gar at the form of the contract of the contract of the contract of after it at a tgo can were I take a a same than engine a CONTROL 18 to 10 o STR. OF STREET OF THEST OF THE OF THE ADJUST AND A STREET OF THE STREET OF THE ADJUST AND ADJUST AND ADJUST AND ADJUST AND ADJUST AND ADJUST AND ADJUST ADJUST AND ADJUST AND ADJUST ADJUS also reserve to the control of the second

A specimen to a secretar or that American Transfer units, Some a Later to Crew engrest to great state and a fing property to the form of the state of the form of the f go arthuse ort or bre de or a tithe de a tithe to the state of th

gree of the ser respect to the first of the series of the property may be rest only to the gentlement of the second section of the section of the second section of the section of the second section of the section berr a see . It is the wind to be the see that the see the see that the see the see that the see

tee transfer

Spherocobattite. Just in torurismate that O. Philadedesia. Perfect thembehing the got to be the same with create a string strong a most open being waxing at Lab a specification of Lights I train Berlin, Lawrer's no orate. Mexico

to uzerra (Ca.Mg F. Ce Co. Rhomb- recent en ent = "4" Color aday brown.

G. = 2.5. IL = 4. Abquidant in the energy tip near of Coloryday.

# 2. traganite Group. RCO, Orthorhombic Vor list of species, see p. 511.

ARAGONITE.

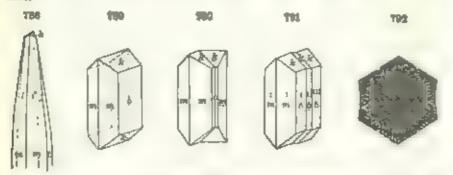
Or he phonolic Axes a - b - c = 0.62244 , 0.72058.

11 5 711 - 5712411 max 10 A 10 = 63 (8) 0 A 011 a 7 si ps 411 4 11 50° 65

Creatals often uncontrate an entractence, in he presence if soute demes or pyran de , wips tw place 11) c and a repetited producing poor dehexago of forms we have 700 702 and the about outside of these or stellar is also seen a the past ried tights in the ram aim and the structure in the con posite basal plane, see high 792 at 11 y he carry takept callement of the of the different section as seen in this section to der the authorities. Also ght that has form at the me, I shapes sometimes columnat, straight or divergent; also stalucture; incruating.

t eaving bible do not use milet. Fro ten so render to la Brite II = 3 1 4 G = 203 2 05 Lighter vitreous inching to reshous on surfaces of fracture Color white, also gray, yellow, green, and violet, streak uncolored. Transparent to translucent. Optically  $\sim$ . Ax p. |  $a \in 1000$  | Bx  $\downarrow \in 001$  | Dispersion p < v small,  $2V = 18^a$ , q = 1.530 |  $\beta = 1.080$  |  $\gamma = 1.685$ 

Comp. — Calcium carbonate, CaCO<sub>4</sub> = Carbon dioxide 44 0, lime 58 0 = 100. Some varieties contain a little strontium, others lead, and rarely time.



Aragonate is under ordinary conditions of temperature and pressure relatively mustable, changing to care to, authorize smally the rate of change is very alow. Crystam of tragonate have been observed which have completely changed to calcule, example of paramerphisms (see p. 358).

Var. Ordinary for Crystalared in simple or compound crystain, the latter much the most commun. often to radiating groups of accordar crystain. b) Columnar, also time

fibrous with siller laster of Massive.

Simurities a stangentic Estate compact of fibrons in structure, as with calcite. Sprudisters is stained to from hardbad Kohema. Consected to groupings of detects inferfacing and consecung seems of a store white color as I tooking a lettle become often calcit fibrigar. Problem Spherical concretions. Turn warned as hand can among lead carbonate ito 1k per cert. From Tarborata in S. can, with the 20th and from Postulpe, section. Zegringts is a cascarcous enter, probably aragon to, coursel greenish white of sky olde with britist from Layring, Storia. Anchorated a at one to can an agrant from Layring, Storia, Anchorated a at one to can an agrant from Layring, Storia to the Linterior, the Sulface and there called conclude an I algebra are apparently parsons forms of aragonate.

Pyr, etc. B B whiten and fells to pieces, and sometimes, when continuing structua, imports a more intensely red to or or the finne than time to become masts time can to white in necessity of at represent each time poster time also and there for personne that any white time of the countries to tense or becomes there are nong broadly when the me craft are areany others or who to two orations to make the mountained by further treatment with an montain sail blue, when the case cubal engineered apparent of the grains of arapeans at converted into a black supports, enterts and refer the same consistents by any goal. Statilly gray

Dall Discuss of the from calcute by higher specific gravity and absence of shoutherhedred cravage from the neckness e.g. until de six for effervencing a meson, becomtant to mill without are limit to higher in specific gravity and view disciplines in the The remains selected free the surfaces is to be a com-

Artif Arago to an form when administrate evaluation are evaporated at temperatures for a 50° to 100° it will form an ower temperatures for the solution contains seem on any or are at a constant of the carbot at an inferior or an in-

Ohe — Aragon to is quich less concition— his occurrence than carets—It is formed are det a m oh statewer range of conditions than call to any temp the new stable form, dien changes to cair to with a change to surrous—ing can it was. It is forture, through organic agencies, as a deposit from but approps, and as a precipi ate for in saline solutions that contage a supplier. The most common repositories for aragonite are been of gypesia whose hois of crus one, especially with addrice, as in the fitymen mines, where it occurs in consbridge forms, and is called five-forri, "flowers of iron." It is found in cartines of besalts and other have of en same any with co, er and two militaries, gardes, on malmante, It

const. (so the pearly layer of a new sheld and the skewlour material of curva).

was dither and portant manter for the year rate of mag are for a In Carchemosnum at Herrengo of the key with divergers. Base bearing an inchemiate the more littera per Stermina are not the early mean their in Robert as a line promote contain or testers thorough at history near historiers of the case, peer of the thor-fore vaand to fine that cover by a bloc same or depend on the proper at a record and the common to from to one metals are not a from the home of her arms a live de Mane, and in twee near that a cat Banton with Lances. The national was brown teach said from Aragen. Some, the miss notable at a reason up to pseudo-hexagonal twin of stab at Missing Province of Castata are the England groups of acts at or waste are following to observe at Austria Main Company March and Francisco. A Company of Selling, at ocears at twin crystain ward are feet an attracted in cause compet-

an the United States in the creation is it is no a some Tours . Latinaster Co. at the borgan I was good at Manada M. or, Manada in the Bank H a we Dances no finefarm is the cream Mes New Mexico as Artema at Bieless and again faceson in large six-

ndea twins at 1 art odins, Colorada.

Bromitto, Amount Half a body mean't Ca(Y), Rat Y, May contain some attempt and HeCOs. Combath and a Thissen therape in a years as I go the old to be I I as 152 1870 2V most from a carrier more of the at Bonn. HI near fants, Curatricia a case and was a te and witherde, also in the garene voice at Funcewhild, near Resham Northumpersons.

#### WITHERITE.

Orthorhoralise Axes a · b c = 0:6032 1 · 0.7302 Crystals always repeated twins, asymbating hexagonal pyram ds, tw pr (110). Also massive

columnar or granular.

Cleavage 5,010 distinct, million imperfect. Fracture sneven. Brittle. H = 5-3.7) G = 4.27.4.35 laster vitreous, inclining to residous on surfaces of fracture tiel r white, votowish, gravish. Sitesk white, Sidetransparent to translacent. Of tienny - Ax pl (010 Bx 1 (00).  $4V = 16^{\circ}$   $\alpha = 1.529$   $\beta = 1.676$   $\gamma = 1.677$ 

Comp. — Barum carbonate, Bat'O<sub>4</sub> = Carbon dioxi fe 22:3, baryta 77.7

= 100.

Invests at 511° C to a hexagonal form special 982° C to an isometric form

Pyr., etc. B.B. fines at 2.1 a new coloring the flame in what green after from reaction tendents. Bly operations with soon uses enacts and as a soil sed for the last Sall the notate by excitore one the set of ever where very much did bee, go as with sui-ph me across who extra a the much as send life, and a Diff. That a miled be its high specific gravity; effectionizes in acid given colum-tion of the flat of B.B. Harrie of send to a beyond in the send given colum-

Obs. We enter so of this and scouper to It is most commut of the premium contains an in a value of the premium of the premium of the present and the second of the present and the second of the secon corrying harts a car somate or by the action of ourbonates waters on their light to minerals

In Figured a portor waster as are of the o March Catherine name stee with galena and North we as he should near flexbarn. At the a technolities to in sarge , one name and the rest of and expensive free appear it we are no re-constant and founds, but I to be broken a steel for the found associated with him to the fire ington her ricky. Also reported from a all transacting with in tidiant township. I have been the district, Or afte, I sould

Use A major source of bartum compounds.

#### STRONTIANUE.

Orthorhotalise Axes a b = 6.6090 + 0.7239

Cry talk often amount of acute species aped, like aregorite. Twice to pl or late common, giving pseudo-hexagonal types. Asso columnar, florous and granular

Cleavage m(110) nearly perfect, b(010) in traces. Fracture uneven. Brittle H=3.5.4 G = 3.680.3.714. Luster vitreous, inclining to resinous on faces of fracture. Color pule asparagus-green, apple-green, also white, gray, youlow, and yell with brown. Streak white Transparent to translations. Optically - Ax pl = b(010) Bx =  $c_1001$  Luspersion  $\rho < \epsilon$  small.  $2V = 10^6$  30.  $\alpha = 1.516$   $\beta = 1.664$ ,  $\gamma = \epsilon.665$ .

Comp. Streetsum errhonete, SrC O<sub>2</sub> = Carbon dioxide 29.9, strontia

70 | = 100 A butle calcum as sometimes present

Inverte to a hexagonal form at 929° C

Pyr, etc. B b review to the way it was to sproute, have only in the that edges, and colors be flatte execut - and the assay review also be after up from M interior with his local order of the treatence ther P have the nated any gives an air se resource the medical to the above treatence the medical to the nation when treated with sulphistic and by we have one of the medical to the continue when treated with sulphistic and gives a above deep at the

Diff. Differs to in related injurging his curbinates, in efferencing with an is, has a being over to get by his arrayon of a convertions without a cover the flame of B B.

Obs. There is the course of white making in most ones or more and set less frequently in our layer ones. It is a couldn't men in small area in the more one state of the course of the c

To the core to their at their of their and of their and at their and the Harry to a finite of the core of the core

I the term a set the residence have book or to the browstone made a consideration of the browstone made set with borne white with the browstone was to the borne white the bor

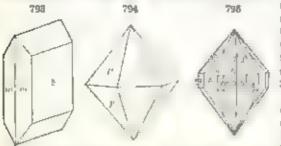
Use A country are of streetly no compounds

## CERUSSITE. White Lead Ore.

Orthorhombie, Axes a:b=c=0.60997 1 0.72300.

Single creatals of each power biology power the course also present tal.

Twins two places 110 and 130 very common, control and production.



twins, often repeated yieldingstx-rayed stellate groups. Crystals grouped in clusters, and aggregates. Rarely fibrous of the grant in the sive and compact; earthy Sumetimes stainetitie

Cleavage: m(110) and (021) distinct. Fracture concloudal, Very britte H 3 3 7 G = 0.40 0.574. Luster administration.

where, gray is black some a estanged blue or green repair streak

uncolored. Fransparent to subtranslocent. Optically -. Ax pl 1/010) By I could The erector p > t large 21 = 8° 14. The axial angle becomes sin por both with shor er way o lengths of aght and with the a wering of the temperature, becoming timescal to extreme violet at 15° ( a = 1804  $\theta = 2.076$ ,  $\gamma = 2.078$ .

Comp. Lean carbonate, Pht O : Carbon Leade 16.5, lead oxade

83.6 = 100

Pre site. In the closed tube decrept step, have a conservation time for each wanted at a lagrante a perst in their man, but were an appropriate an expect of the tornal flower oversay, and in it is wishes as our lone. Sales as at the at me as I with

Diff haracters of by high specific gray a set is amanyone later now on a set signed to B. I. we neglected to offers ones with the set of the second of a conference of the first ones of the best part and to be a set of the second of the conference of the second of the so to the the two dear through a pureus men orang by he action is a a somice

coluthia upon a load plate.

Obs. Consequence and the interference are origin. It is for the brings there a new 4 how there are been produced that the district of after the a new pain for so to my it has used been noted to a new which transcribed to these own. I as ere is agree and with galence, anglessee and no refer characteristic manufactor of the City, apres sent April

I project as a community shoral, the curve there are I was a temperature of the exception. Large resting the real is that is each new tier a neglecture is observed. Laplace Manner Brown in the real of the said as I light segment or the said of and Certain at Acter 1 at the railte, at Tree a suger a remain I see him a to Branch of Ruden. In his over at a transmit, We say we and the norm and Holgs the store On a country the most water is as a to the nord expect a at Manager as a Material country to the Lands, that a trace of the most poen according to the country of the store of the most poen according to the store of Cake. . . . When Man per to the Dischot River,

Arrange and the mer of the track which makes there will be the make the prince of the ment the sea to program at hard to the to the a tree of the expense Man, over Law Craces Is no Ann Co. New Mexic. to Ann a the Corner Anno construct

at Weniner and chewhere

Use. - An ore of tand

### BARYTOCALCITE.

Monoclime Axes  $a - b \cdot c = 0.7717 \cdot 1 - 0.0254$ ;  $\beta = 78^{\circ} 52'$ . In crys-

Union that Translate

Charage in 110 perfect c 001) less so. The three clear ge planes make the re with each other but the tent to see of the problements characters of make major of reducto structurally it shows reactions to call by a title to the hence. The ann ech arrange two processes I so to move a residence en 1 Beit le II : 4 (1 = ) fil : 66 la ster itprops, it many to resumes ( for the company of any and the street with the street parent to transferent of  $\alpha$ ,  $x + \alpha = 1.55$ ,  $\beta = 1.684$ ,  $\gamma = 1.686$ . Ax pl 1 (010 \ \ \ 2 axis = +64° 2\ \ \ 1

Comp. (ar senate of barries and casesum, Ba(10) (a(1)) = Carbon

dioxide 29 6, paryta 5, 5, hair 18 9 = 100

Pyr., etc. B.B. colors the flame we'll wish green, and at a ligh temperature fusee in the thin course and again in a pale great for the gate track share effecting this So the primate by tendonte upo, we toffervoice see Taline colonies gives an assumant precipitate, BuSOs with a few strope of suplaine acid.

Obs. - Occurs at Airton Moor to Cumberland, England, in knoestone with harite and

Bigmatosphilite — RectOr., 2BirOr. In spherical forms with published structure. Color so in to gray in the spherical Tractal to a 2.1% of 1 of 1 ft = 1.5. Color structure. On a 2.1% of 1 of 1 ft = 1.5. Color structure. appropriation matter than a frequency of the first a frequency of the formattery but ors to Madagawar at Angaing de near Manurar to an emenore per to an ele-Means to be against me for it by executant from the grant of the figure and at W so the not Jurian a Controctions. From the Stewart have I am Sun Diego Co. Can # 12

Rutherfording (rans) carbinate, 1934 On Onhorhumba. A reliew other resulting to a secretary a form or ladges 173-180. G = 4.5. From Cruguro Mar.

Tange an I come I have to a

Another the Huo, and Outlieber has in small primingle with current form and edges H=4 G. = 3-9 Color with realist arrays become grant topically as = 1-25, 8 = 1.700  $\gamma$  = 1.735 In some long Narrayah recolor. I Acade in turing, our ways pittle as reporter from Hours Unit in our E. da. pendental to there I want the print from Langer affect to rear to a real to paper a

Ambatoarinte. A carbonate of structure and the pare various continued of the line Parinte A Constitute of the owners are me to the Parinte A Parinte of the owners are me to the parintenance of the owners are me to the owners are

below the or mata disease. Hatat premide or promise Cristale harmen the growners with the airs combination of north Bana compage. If with five 4 Sec. Court from a court of the court of th repulsivies. In pognisside venus of the grande as Unincy Massachimetta, and from his sale, M a na

the spirit is a parasite containing furium from Naturals, South Greenland, thank material from Nanaresis the grants to be a new ages so and names agraduate in product of per min. A car of the mem around to able which particle are not further than the construction of the car are the first and the first and the first and the car are are are also as the car are are are are also as the car are are are also as the car are are are also as the car are also as the car are are also as the car are The are now e endote turnly to tantamete. Confying a nine may to show a structure differ a record of the control of the contro

A fluorathonate of the remain metaus RF f Co. plant a manufacture or day on an amounter community profession of a sub- Broom parting H = 4 tr = 4 th s cour wat re wit writing read the large of ten i haven bring in softhe Barniska hiver on his a retend of an intito paraget growth with typomite in the Pike a Peak region in Constado.

#### PHOSGRUITE.

Tetragonal Axis c = 1.6876 Cevatale prismatic sometimes tabular

Pet001 Normal symmetry is shown by X has study

Cleavage m .10 a 100 distanct also r 001 | Rather sectile H = 2.75 3 (, = 60 o 3 fuster adamantine Cour where gray, and yellow Streak white Transparent to translatent. Optically - | \$\operall = 2414 | 1 = 2 140

Comp. — Chi recarbonate of lead (PbCb<sub>2</sub>CO<sub>2</sub> or PbCb<sub>3</sub> PbCl<sub>3</sub> = Lead carbozate 49.0, sead claiming 51.0 = 100.

Pyr etc. BR nests methy to a yellow globale which on noting becomes white and create, in the rease a tell figs on meta a wald with a se in tag it lead characte. They were with effort message to brute notice and and adultion tracts or oblishing WIET MINER IS NOT

Obs 1 were was a rare majoral found commonly in an original with recognite and a ports of the street con their and in a treet to en incomment of He set M of a Mercento near Ignore and at the treat term of the store of the set of the the result of the action of sea-water upon ancient lead sings. In Tune at Nich Amor-benSalem and at Taume? year Olave, South West Africa. In fine crystals from Dunday in

Taninania also from Broken H. I. New South Wales.

Routhupite: Mgf O New O. Nach I isomeone preshedrois R = 35-4 G = 2.38. White to be an a gray of a 1.44. have a figure after attack, from shape waters contain ago small amuses of magnessian in solution. For Rober Lane, has Bernatdina Co Child it a

Typhtie Mgt (), 2 Naf (), Na, N), mountain Octabella, abit B = 3.5 C = 2.5 n = 1.51 Ens., for do Very rure From Borse anne, Suc. Bernathand Co.,

California, associated with north spate

## B. Acid, Basic, and Hydrous Carbonates

Yeschemacherita. And airmoin in carbonate, HNR.CO, Orthornoladd. In vellowest to while exectant (1 - 4" H - 5 theorem 145 1 and broke guarant deposits on the coast of Africa Sandanias Bay and from the west coast of Paragonia, and on the Cherchy Injunera, Pretty

### MALACRITÉ

Monochure Axes a b  $t = 0.8809 + 0.4012 - \beta = 61° 50°$ 

Crystals rare vide met, as ally sletter, accordar prises were \$10 a 110 = 75" to , grouped it talks and rose tes. I was tw pt at 100 common. Commonly in easily in there and, with surface horror of at several to, and structure I verget , often delica ely compact fibrous, at il basited in colit.

frequently granular or earthy

Cleavage a fol perfect, 5:010 less so. Fracture solve rebotist, ineven. Britle, H = 35-4 G = 3.9 4.03. Lyster of crystals adamantipe, in lang to vitreous, of fibrous varieties in a or less sake often Lill and earnly Color bright green. Streak paler green. I reasslucent to subtranslatent is opaque. Optically  $\alpha = 1.65a$ ,  $\beta = 1.87a$ ,  $\gamma = 1.909$ .  $2V = 43^{\circ}$  As pl 010:  $X \wedge c$  axis =  $\pm 23^{\circ}$  36 X = nearly colorless, Y = yeliowish green Z = deep green

Comp. Basic cupric carbonate, CuCO, CutOH4 = Carbon dioxide

199, cabrie oxi te 719, water 82 = 100.

Cupromerus and paragrachusise are mainty given to this beating mulacly technic manufalls from In the near Other St. t. West, Albert, I that see to have 20 - 9 2 n. 1 a apto alphometric ate like the effect of the first the state we not post our menda early and triby only be an attended and entropy malachite. See also begin to blue a

Fyra etc. In the choed the do keeps and opens water. Bits loss at it courses the flame emperald give an chargeout a red area to metado copper, or the the flame teneto sky

Defi Character of hydrocontents

Defi Character by give and and copper reactions B.B. defices from their copper on a give on the affective source with no be Artif Mahadise has been formed artifactor to bearing proceptioned copper carbon-

ale with a second and and and the contact the for several cases.

Obs. Mrs. on a kin is union of our per so tribut the nor in the obsertant some of our per deposits, where it is made and with after open if it per not in the product of their alternate. I be outerpressed in the commencer and the interest of their state of the outer can be open-copied ones. It has been found in surge some into a did in the standard and the I rail Min must be the faction of a best of the month of of transcribed was proposed with be producted intensity to construct of the faction of the faction of the mass accounted at top these of the month of the continued in the last transcribed of the participation. Must be the material was more for origin in the spaces. From Montawa to be Stand Flurance with the tals from Being r near sugger Rhemai Prissus Troto Chesey near to a literac benner. In orniwal at Leasurer and elsewhere. At hatsigs in the Je gain torig. In September Blue men at the age. Mr. we as I march mar Clave some West A can and a hangte ounland, Cape Proyince, South Africa. In South Australia in the borns distres one at We reduce the

In the United States the following localities may be mentioned. In Pennsylvania in Berke Co. a birone taken g masses. In the copper makes of Thick own. Innaessee In Arrama abus to the teamer master and have alater stant will restore at the copper Queen made Big on a mast to be an member? as Mirrary Challes for a cation, a stancetitle forms of his man to me and a concepting hands make at the factorist, this ( or I complete, rute be Takin district, I tall, and in passidomorphs from Good Maringo, No situ

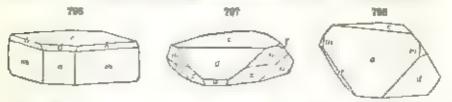
I a get the a perform mailton at he all amone to the green come. Date. An ore of copyet at his resident stranscends oftone

#### AZURITE. CHESSYLITE

Monoclinic Axes a - b, c = 0.8565 + 0.8844 - B = 87° 35'

$$mm^{-1}$$
,  $\{1,1\} \land \{1\}0 = 84,86$  (P.,  $\{23\} \land \{0\}3 = 61,90$ )  
 $(m, 0)(1 \land 10) = 47,06$   $(m, 0)(1 \land [0]) = 1,4,00$ 

Crystals varied in habit and lagt y model of Also massive and presenting that a we samples, having a continual composition, also can am, early,



Clearage pro21 perfect but interrupted, a 100 less perfect. Fracture conclusival Bride II = 3 a 4 (1 = 3.77 3 xB Laster tyreous, altried a mountain Color various shows of acree-tilue, pressing non Bertinlike Streek blue, lighter than the color. It aspared to sail translucent  $\Theta_1$  (really  $+ -x = 1.730 \text{ if } -1.83 \text{ if } -x = x.838 \text{ } 2V = 68^{\circ} \text{ if } Y = y$ (510)  $Z \wedge c$  was =  $12^{6/3}$  Hereigh al dispersion,  $\rho > c$  X = Y = 1clear | m, Z = | to purp. | to

Comp. Bur upra car onate, 2ChCO4 Cu(OH); = Corbon dioxide 25 6, captic oxide 09/2, water 5/2 = 100

Pyr., etc. - Same so in malacliste.

Diff. I have crossed to do I be color effertenembre is a tale and employee the bound 15. Et

Artif trente are been forward in alle wing a substant of capper attrate to lie in con-

that with Imments of calcule for several war-

Obs. It to be a finite or one process than material but like the integral of secondary or go, to the feed we are pure in it are or entire of the best finite order of the confederation which is the confederation of the c a fail and fine I be the some of a chip of the contract of the the course of a set one on the speciety blocker one or a subserve of I cake as to be a fire the reserved of the server of latter by a contract of the server of the serve It I go a greature 1 grow many the agree, Queensances on South Australia at Mounta, at A clarks and mur h total to

Notice and was a retroil States are few the chief being a Armoun at Budge and

Moreover at at his New Me are

Use to one or year

Rossayte: 4 to 10, 1 a Ze + H . In many flars uplicantes. There break a cotate tang mar pances with table and tang a linear very large treat of the formation. The formation is a linear very large to a linear very large to the linear very large to the linear very large to the linear very large treat very large very la

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to Russia, operates with allephane, etc.

Thermonatrice El rom process some of the first operation of the second o

The questions of the second of

2V = 53° Ax pl. 1/001 K = a axis. From a coal same at Nesquishoming, Schuylkill.

Co. Pennsylvania. See lanefornite, p. 531.

Natron Hydrous so man curbonate, Nat Ch ORgO Occurring in nature only in solution, as in the soils must of higher, Nevada, Candonna, etc., or mixed with the other pomicas carbonaces.

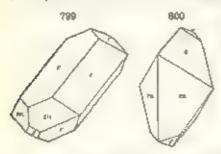
Pirasonite: 0.000, 0.200, 0.200. To primitive erystals, eitherhemitic-hemimorphic H=3.  $C_1=2.36$  Leavy families. Coloriem to white. Optically 1.000 at 1.000, 1Co , Caldornia,

### GAY-LUSSITE.

Monoclinic Axes  $a:b c = 14897:14442; \beta = 78^{\circ}27'$ .

mm , 110 
$$\wedge$$
 1 $\overline{1}0$  = 111° 10° cc', 011  $\wedge$  0 $\overline{1}1$  = 100° 30° ms, 110  $\wedge$  0 $\overline{1}1$  = 42° 21°,  $\overline{\pi}'_1$  112  $\wedge$  1 $\overline{1}2$  = 69° 29°

Crystals often clongated I a axis, also flattened wedge-shaped. Cleavage: (110) purfect, '001 rather difficult Fracture conchaidad Very brute



H = 2-3. G = 193 195. Laster vitreous. Color white, vellowish white Streak uncol red to gray sh Translucent. Optically -. p = 1444,  $\beta = 1510$ ,  $\gamma = 1523$ .  $2V = 34^\circ$ . Dispersion strong, p < v Ax pl 1 (010), Z A c .x.g = 14°

Comp - Hydrons carbonate of calcum and sodom, CaCO, Na<sub>2</sub>CO, 5H<sub>2</sub>O = Calcium cortionate 33 8, 80d. im carbonate 35 8, water 30 4 =

Pyr., etc. Reated in a cheed take decrepatates an absorbes oping at BB force cased to 5 with each st, and or in the flame of tensely your work that he made with a

Disk offer seconds party most in its water and limb as turnoring paper.

Obs - At what at long i an own Meria, a decreasing person and company distinct at the lettern of a small like a school of the covering tours. In case and essent distinct at Lake a second with a the trace reserved tour Baylow, Norman Lepson of the trace of exert near Baylow, Norman Lepson of the according to the covering tours of the according to Newsconder Valley, Wyoming Donned after the Lusser the Proportion of the according to the Newsconder Valley, Wyoming Donned after the Lusser the

Latthurste. La. Inter g(t), g(t), g(t), g(t), to task tolerant orthorhor the creating, also ground where park values t, perfect t = 1, t = 2005, a finding t is consistent at earlier t cases, t on t of tcore of the hear to be a bringly a man as a most of telegate park expenses in the soil n few feet below the surface at Friedenavine

#### TRONA. Urao.

Monocland Axes o  $b = 2.8460 \cdot 1 + 2.9700 B = 77^{\circ} 23^{\circ}$ ca, 001 A 100 = 77° 28°  $co_1 = 001 \times 11_1 = -5 = 53_1$   $co' = 11_1 \times 111 = -47 = 35_1$ 

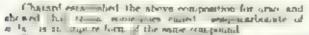
In places 1001, or chargated il b ame, often fibrous or columnar massive. Ceavege (100; perfect, (111), 001 in traces. Fracture opeven to subconchordal. H = 25-3. G = 211-214. Luster varrous, glistening

ø

Color gray or vellowsh white Translucent Taste sikaline. Optically  $a = 1.112, \ \beta = 1.492, \ \gamma = 1.540 \ 2V = 72^{\circ}$  extrong dispersion,  $\rho < \alpha$ Ax pl  $\pm (010 \text{ A} = 6 \text{ axis})$  A canal = +7

Comp. Nact O. H Nat O. 2H, O or 3 Nact 40 O. 5H<sub>2</sub>O = Carbon da-xide 38.9 soda 41.2, water 19.9

= 100



Pvr, etc. , be seen to be chis water and carbon dicade. B.B. camby furable and converte to be faring. See the moster, and efferymore with

bear a war on the magnetic tem paper

Obs. I make of found in the Jepositor of engineer nature or in precluded by the extent of the extent the series the province of term, it there, there is many major a new fire the secta lakes West Satrice of the secta for the secta failer of the extent of a lake at large the forest of the extent of a lake at large the forest of the extent of a lake at large the forest of the extent of a lake at large the forest of the extent of a large three large to the extent of the ex

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7 19 1 1

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Hydrotainte Mg Mg OR TALOR Alla Hengmal Langlar massive. of a manage of the first the property of the p de la companie de la countles, New York,

Pyrocurite. McC . 5Mg OH . 2Fe OH . 4H.O. Hemgonal Weav studies ordi-suvery white color a seport or so I and a row worth of before Sherman meants, Songland free later mate,

by the r Con similar to promute above but a factor loss from the east t for the hand the series of the series of Arabitah

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From the Lague frame great a song probatilistic at

# Oxygen Salts 2. SILICATES

The effective comprise the large ser large at growth arring at needs. This show a we reger compared what story on twee compared the ar is long to the or better them as one has revenued major and surface

mental facts concerning their atomic structure and thrown much light upon the introduce problem of their contrast on. It is now cotal short hit the stign of the same inching on 1 of a con 11 those 5 th groups it as the states topostary at our nar washed of one at both and enter by surprise In the certicol cares these both green a west marganizably with real pass to the other eathers as a reliquian as the transfer to the contract of the material and the contract of etc. In ser types for, step to waver the Sett, groups are larked together his histing one or more it ago if asym sharest it wastern by the gulary of go in If two at went as the graph tast our and if caagen it continues record for it after the Chief of the first of the agency for the chief Further to the greaterness term chains in what two caseen atoms of two a tracent graph are that wall a burgle charle of his promits of our tue to be opposed to he a be at in far overe long the characte the parent king the tier groups a contract in respected, by the but Change may be live a chrain gether to form a sign a ger about thought to be all marteness of the arcas, with a companion of malls. Again the at speg of the specific acceptance of a territoria toke poor in acting so men treat threedirected in a metal rice and a group by parties intenstic of the 4 florest torms of a contract to fund of and have go a partial for accepted of Six not by allow the high an extensive and notice the man be obtained by which base at marker to the entire termination of the first property of the entire termination of the terms of the zenties when their advantant war trans a substituted or each ther and the water centers tarned with it disturt ag her in largepta, are supplied in these vaccounts developed and property and property are powed in such was as to hip I free who entruct relogit, er . It has been to we that where your of the company takes pure the partitor of an area at one in without and off we are workent for each use, and of the strice time Annations in company in that product the substitution of S by Al. of A. Mg and he to each ther of hada Ca, etc. A general statement by Bragg" is that a secure should be regarded as a strict in having a constant number of oxygen at one up the cond with a constant pumber of plans for the tall about a not car to bled a these elements a varying propagations. do marteral recta a beliable set ween variously

It can be espectful this year of the structure of the affectes large's discussed was such that as a part assumption of the autorice of that can be as expensed endeaded and a respect to the end and endeaded and a respect to the end and endeaded and a respect to the end and endeaded and a respect to the end at the end a

In our tensor of P streets of a true, in particular to use the greatest und the manery business are ear. Furthern on a tige not for all the acceptant in a tige not for all the acceptant in a present of the acceptant and acceptant and acceptant in a present of the acceptant and acceptant in a particular acceptant and acceptant acceptant in a particular acceptance and acceptant in a particular acceptant a

<sup>\*</sup> The substance of these parameter to has been constanted and a set of the Structure of Six agents by W. L. Braget, Zit for Tit. 2-3.

the elements forming the water is as yet uncertain. Furthermore in the cases of severa, groups it e succe arrangement must be deviated from, ance the relation. I the species is less exhibited by introducing the related bydrous species named atom of critic them.

The chapter of sea with a section including the Titanates. Sil co-titanates Tituro-ni bates, e.e. which connect the Suicates with the Nobates and Tantalates. Some Tranates have already been included and up the Oxides

### Section A. Chiefly Anhydrous Silicates

I. Disilicates, Polysilicates

II. Metasilicates

III. Orthogalicates

IV. Subsincates

The Districtors. Rescale are easts of distinct acid, HSnOs, and have an except ratio of a local to bases of 4. 1, as seen when the formula is written after the district method. RO 25 O<sub>3</sub>

The Potential vota, it's th, are sales of polymbrae acid, Habith, and

have an earger rate of ( I as seen in 2RO 35 O),

The Mexican textes Reselv, are salts of metaal me and H & On and have

an oxygen react 2 1 shes have been called book ofer

The Chernology ettrs  $(RS, O_k)$  are so a of orthogeneric and  $(RSO_k)$  and have no oxygen  $r_k \to d$  : 1. They have been called a conscates. The may carry of the squares fall in one of the antitwo groups.

First, one to there are a master of species characterized by an oxygen ratio of assettion 1, 1, 1, 2, 3, 4, 2, 3, see. These basic species are granted as 5 assignments. The ratios position is often in doubt to noise cases that are related to be regarded as basic seats becoming to one of the other groups.

The above come in them cannot however, be carried through streety some there are many species which lo not exactly conform to any one if the groups named and often the true interpretation of the composition is I global by the placemore within the most of a surgic group of species connected covery in these contact there may be a wide variation in the proportion of the order element. There the pretime fortegars, placed among the providence of a range from the true polyaciente, NaAlbath, to according to the scale of the surgicial and an arrange of the entremed of the surpounds regarded as group, which however is most be an original categories and the arrange of the compounds observed approximate to that type. The mices form apother example

## I. Distincates, RSigO. Polyailicates, ReSigO.

PETALITE.

Monoclinic, a:b=c=1.153 1 0.744  $\beta=67^{\circ}$  34' Crystals rare

send rate I supply prosence fol chall emovable (petable).

User up a could perfect on 201 cases, a  $^{2}$ (05) deficult and imperfect from the imperfectly conclusived Brute. H = 6.65. (, = 2.39.246. Inster vites as no 001 pearly. Co-cless, white, gray, occasionally reddish or grownish white. Streak directional Transparent to transport Optionly +  $\alpha = 1.504$   $\beta = 1.10$   $\gamma = 1.516$  2V = 83]. As p. 1. (010)  $X \wedge \alpha$  axis =  $2^{\alpha}$ -8°.

Comp. - L(Al(S)(O)), or L(O) Al(O)(SS(O) = States 78.4, alumina 16.7,  $f_{1100}$ , 4.9 = 100.

We so heater beer age to ratial between 1000 and 1 00° am isotropic at 1306° (

Pyr, etc. - and its heated engine a man phosymprosecut light. If B fuses with all 5 and gives the reaction for other. With horizon bergan a stear, colorless glass. Act meted

on hy arrest

Obs. Petaldy scenes of the non-more on the island of '10, State of Stockholm, Sweden with reput ste, tournative, spediament and plant on biles mathered. In the I have been at the a thempoter in Massachuset a weat restricte, at cert the rd things with specialization in the The quare policies in this receipes, and alle mix the color ager

[cd) 4f att 4Bert A at 248 to 14a). In her gone, prisone, Bergert with 8t at 2) here sections abowing my more near an alleger of the heating error and at 1% of maxim with address Ope and Indices 1 529 4:12 H 5 5-0, C, = 2 55-2 to face a figure Colorher to one green, given brom Vanta d, portament of

Ruersa at Vol. Invetach, urraona, Swi serland

End-dymite H valided at , Min or our to white glassy two ad crystals, tabular in he at, Out Lanches winting on Out leavester Will be created the analysis of the leavester of the structure optioner are note at lapsachemite. Have, and the structure optioner are note at lapsachemite. Have, and the structure options are a last, and the structure of the struc 1 feet to his

H f - 457 Optically to w 117, - - 1 5224 From dousy envises as a compegnatite verns at harmonic, (creenand

### Feldspar Group Managlania Saction.

	G' probamin na			n.I
Orthoclase	KAIS O	0 8585	6 ¢ ] U 55554	116, 3,
Sodn-Orthodase	(K,Na Also,Os (Na,K Also, b)			
Hyalophana Ca san	(K.,Ba)Al,St.On BaAlsSista	0.0584 : 0.057	1 : 0 5512 1   0 554	115° 35 315° 3

A. Triculate Section

KAIS O. Microcline IK. Na AlSuly Noda-murrochne (Na. K. A. SuO. Aporthoclase

# Albite anorthite Series. Laspocius Febispura

Albite	NaAlSuO <sub>6</sub> 0-8335	b c 1 0.5577	94" 3"	116° 29'	88 9'
Oligoclase	0.6321	J 0:5524	93" 4"	116° 23'	90* 5*
Andesine	("NaAlS (O) "CaAl <sub>2</sub> S <sub>3</sub> O <sub>1</sub> ) 0.8357	( 0.5521	93" 23'	116° 29'	89, 98,
Labradorita Bytownite	0.6377	t , ii 5547	93° 31′ 93° 22′	116° 3′	89° 541
Anorthite	CaAl <sub>3</sub> ShO <sub>4</sub> 0:0347	1 0 5501	93" 13"	115° 55'	81, 13,

The general characters of the species belonging in the Felderar Group are as follows:

i ("gates ration in the monoclina or trelime systems, the crystals of the different species assembling each of a closely in angle in general later, and in methods of twinning. The present angle in all cases differs but a few degrees from 60 and 120° A-ray at by of the holdspar through shows the close an later in structure that cases between as members. Four molecules are contained in the unit cell.

2 Cereage in two smaller directions partied to the base could) and charpinscould or brachy pascoul, bollo mode of it an angle figure or marry 90° 8, Hardaces between 5 and 6.5 4, Specific training varying between 2.5 and 2.0, and now y be ween 2.55 and 2.75 5. Color white of pale shades of yellow, red or green less common a dark. 6. In composition, while magnesium into tron are always absent that the marrier, besides the several distinct species there are many in errored with each other by insensable gradations, all the members of the semi-showing a close relationship not only in composition but also in crystal as form and priced churacters.

The species of the Feidspur Group are classified, first as to form, and second with reference to composition. The managinar species include see above). On the classe, potassium, bispur, and Sopa orthograms, potassium, and the classes of the control of the contr

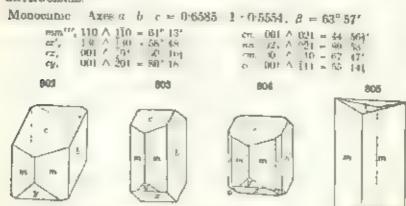
Bothum fellspar also Hyalophane wil Chistan, burning feltspare

The tricking species include. Minimuterive and Anorthograss, potassium sodium feldspars. Albertz, sod um feldspar, Anorthite calcium feldspar.

Also intermediate between albite and anorthite the isomorphous subappears, somm, common carcium-sodium fel ispars. Oligoriaas, Andraine, Labradories, Bytownies.

### a. Monoclante Section

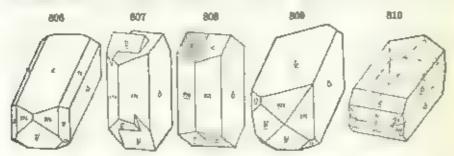
### ORTHOCLASE.



Twins: two pool at 1000, no two was a the common Carlohad twins, either of arregular parameters one Fig. 807 or or the type the latter appells with \$(010 as composition-face, often out. Fig. 808) with \$(001) and \$r(101).

81.0

pearly in a plane, but to be distinguished by laster, cleavage, etc. (2) n(021), the Roman twins forming hearly square prisms (Fig. 869), since  $cn=44^{\circ}$  56), and hence  $cc=89^{\circ}$  53 often repeated as fourlings. Fig. 473, p. 192), also a square prisms, clougated a axis. (3 c,001), the Manchach twins (Fig. 810), usually contact-twins with c as composition face. Also other rorer laws.



Crystals often premater care, somet mes orthorhombic in aspect (Fig. 805 since c(001) and r [01) are included at nearly equal argies to the vertical axis, also clongated a axis (Fig. 806 with 6 010) and c(001 nearly equally developed also thin tability b(010) rarely tabular a 100), a face not often observed deften message coarsely cleavable to grain ar sometimes lameliar. Also compact crypto-crystathne and flint-like or justice-tike

Ceavage 1001 perfect (010 somewhat less so, pramatic mello) imperfect but usually more distinct parties as one prisonate face than to the other. Parting sometimes distinct partiel to a 100, also to a term-orthonous melined a few degrees to the erthopinacial, this may produce a saturble hister or sentage p. 275. For latter also often present when the parting is not distinct. Fracture could odd to uneven. Britise H = 6. G = 2.56 analarm 2.57 258 considers. Laster vitreous, on could often pearly Columbia, white, pale yellow and flesh-red common, gray, rarely green. Streek anothered

For administ,  $\alpha=0.519$ ,  $\beta=0.523$ ,  $\gamma=0.525$ . Sughtly different for sanding. In adularis the axip is z=0.00 with Z=0.00 axis, X inclined only

sandine. In addition the ax p = a = a to with p a few degrees to a axis (  $+3^\circ$  to  $7^\circ$  of Fig. 811) or in varieties rich in  $N_{\rm e}(0)$  from  $10^\circ$  to  $12^\circ$ . Axial angle variable. Usually 2N = a is a  $70^\circ$ . When non-arise is heated the axial angle diminishes becoming  $0^\circ$  between  $600^\circ$  and  $800^\circ$ . Heyomat that point the axi problemous (011). Sandine has this orientation for the said plane with a small value for 2N. Dispersion p > 1, horizontal, atrongly marked, or included, according to position of axial plane. Outcally

Comp. A splicate of alumin un and potnessium, KAISi, i and K<sub>2</sub>O Au<sub>2</sub>O<sub>2</sub> ASiO<sub>3</sub> - Sites 64.7, alumina 18.4, potash 16.9 = 100 - Sosham is often also present, replacing part of the poinssium, and some-

tunes exceeds it is amount, these varieties are embraced under the name soda-orthociase (the name burbierite has been proposed for the monochuse

phase of NaAlSid), whose existence is known only in crystal solution in

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but 1 > prop nost varie or depe 1 pun crystaline an it and method of sec r-

the post and the post area of the post area in the contract of the post area. le de le often with vicinal par s. Bavein (wass common. G. = 3/s 1 . s. the state of the s I see an author's sometimes when we when a present of the t eta tres a establique i ergradia de a establica de la establ

a fine our plant are again to a group of them there when a sure given by one or or other than a sufficient of the state of the second of the seco the court of the best teached to early a strong to the part of the

che a sola l'ante free, Mita a Vigina

to therein a diame, where it is a material bracket of facilities from stroim plays stream. without war sould be too a variety that we get could be, with all county to

otherwise lose adulates

4. Defences. Directalis, Carlobad and other twill a common also monocoroles and ethe property of the state of th that a the two sex or Charte P H --5 CAN CAME CAN STATE to began an a partier, with gold-yellow reflections to a direction

The color of the section of the first that the color of the section of the sectio polarized light (errored arcule).





Pyriett. But I were at 5 same eine einen vong om himsels are more fan ble. Te greeken er at 4. No over part in a 20 hl visit poweren digments und bestels. is it, gives violet potamenta flame vasore through lone giant

639

Diff. Of its erized by its crysta, the ten as, I the two clear ages at right eague a one of the section of M to at a state as well and a second action of - a comment of the to alteration from wenthering, thus a specific to a great the property of the prop Ard we will one of any See the feet of the see the se Topics and a second as a secon market me and a house the same of a line is a line in the same of the late of the same o to tent glass and truck Alter. Orthoclase streets to a new outer the grant of article of grant of article of grant of article of grant of the gran to the sectional and and often report time space a new pares. [ad | ii = Obs. a serial furnish burns the created as in figure as read by one at The transfer of the second of t and a gibe of the second of ye space my to show the first of the state o at a the except on restary picks about on a to gray and as a ring of ern a serie conflicts the next consider of a a a security herefore a the second the first and legal to the state of the first and the firs to the tendence of all the more to bear and er in the retreat of the major the standard the ground the the set was given a some a me we at the come of the ben hagfand at up to New York in the Lawrence Car to some extractions and the safe H. and an a splease from Not a regarded from a few and from the same from the first the same series of few and from the first the first the form of few and from the first the f

Consupressing in Case stress from Mean variable, can Diego vio

Gee. - In the manufacture of purcelam, both in the body of the ware and in the glarethe Its surface.

. Little are. As from described, a flesh-ord aventuring feldings from Perth. Untario. Comage, ruled a mathematication, but shown by Certar L. commet of interlap nation orthothere and a total. Many sequent accurrences have some sero o ted, as use those to which the restine and at the are an last a interfamination, the at er railed microcane with the are my members, to portiate this is true in part of the original peritite. If any the structure is assert the out is to the help of the angrees perit is called a property to. Brogger has an ear give | 1 st tay the microperth, re of a rway to, and shoet fol spate charactered by a marker tell, or the assumes the existence of an extreme a fire interior instinct of a, to the second second second second be by the minimage try per his all conference of with second to wisees the same man array I have so a hartest figural g however man a concontains that result, and he has bee he are les that securities of als a hour parties ri-C . C A' F5 This accurate for the art mate intergrowth of adherent featspars shows in the perthetent

Byslophane. - A harian hearing adultria orthoclass. It touch with Balt Stole in with the early case modes are as any a top out the eventue as a large as held by sits p. 5.6, and increase the energy out perfect, about somewhat tensor if  $\alpha = 1.42$  and  $\alpha = 1.53$ , and  $\alpha = 1.42$  and  $\alpha = 1.53$ , and  $\alpha = 1.42$  are the first perfect that the energy is a superior of the energy is a superior of the energy in the energy is a superior of the energy in the energy is a superior of the energy in the energy is a superior of the energy in the energy in the energy is a superior of the energy in the energy to the former of plants of plants around a harries to confinite to the Banco-tan Value, was a line form wears of the non-games of the no ballety in the Secret wife better Verpusaid, one at the operation lives Oreland, to Oreland Noted at

Frank . New Jerson

Cettian. But S.A., a miler in con one time to anorth, is, but comming become inrise to design the winner the crystale curwing at a terroi for a twinner according to Carriero, Maintan and Bareno man which marable case to H = 6-65.

1. = 7 (corress Option v + a = 1504 pt a 1500 pt a 154 21 = 88° Az.

1. = 0.0 Z forms = 28° From January of the bordenet, berndard. Sunder Name but the enthorner gives to n at read critical and orthodase. Personner from 4 stoley is, Toos valley, Desimont, Italy, is the same species.

### d. Tricline Section

### MICROCLINE

Freding. Near orthoclase in angles and habit, but the angle be/010 A 001) = about 89 30' Twins like r' viense, also polysyrthe r twinning

814



according to he alste shiperil be laws op 544 comer a, producing two series of fine t perior conent nearly at right angles to each other here the characteristic grangestructure if a bush seem to in prostigned light Fig 814). Also mustive cleavable to granular compact.

Clear go fit period 5 010 water what less so, M I 0 somet ness distract m .10 and semistaries lateral, but seed easy Fracture upeyen Bentie H = 6 6 5 G = 2 54 2 57 Luster vitreous.

on cf0011 sometimes pearly Color while to pair cream-ye lew also red, green. Transportent to translacent. Optically - Ax p nearly perpendemar 800 84', to broth Z inclined 15° 26' to a normal to brotto) Deperation  $\rho < v$  about  $Z = \text{Extinction-angle on $c(0.01)}, +15° 30 , on <math>\delta(0.0)$ . + 5 to (Fig 819, p. 542) \[ \alpha = 1 518, \beta = 1 522, \gamma = 1 525 \ 2V = 83°.

The mountial identity of orthodox and magnetine has been urged by various authors on the grace has we properties of the former would be any with appreciate A sure and secure twinning now self the acres acrossing to the abute and pear the laws. If never, night had rea, i derended a special grant on bost an inches a preparation of the first special Firther it has twen shown that other one overte from at some to sandtime at 900 t. whereas marrichne remains unchanged up to its theiling faith.

Comp. - Like orthoclase, KAISuth, or Kell Al 1, 6810, - Silica 647, alarmina 184, potash 169 = 100 Sostium is detail) present in small amount : sometimes prominent, as in socia-microcline

As for orthogises

Diff. Reper has exthemase but distinguished by optical haracters og , the grating structure to principal aght, Fig. 8.4 also also shows fine twinning structions on a tours. ourface solute aw

Micro - In this sections like orthoclase but usually to be distinguished by the grating-

like structure is prosture at the more mental or is. Obs. Much if he prosts to impart continues a summed as orthogonal technique here, in general, spir an scalera trates except to establish up "formore in tender are in tabler the earlier of the set of the can be month ned here. Bes, I am more the name on the green variet, or a to the other Wite or hat here one in the Frank. It is not at Bases on long. Maggarre, Pare mont itals the min a research tragers a count has a hit and types near breakturn and larrak in Vertical size. Found in the gern bearing pagarantes of Madagamar

In the I ted states it for its in Percentrana as the variety chestrife at Penchouse quarre West Pr. re l'ester : an maverture ribert si t. p. 163]. De au co Co he have a see if we have a to begin a late on a of age a no of the crystant with days come in the grands of the Pike a Peak metrics and at Phonoment, I show

Co CARRIAN

Use some as for cethor are more tone as an amamental material on anomatone Anorthocane has read to related the to be being a fine from the first and the first an Two may not with with a see to a partie score and to the at the se test that I will the name the twing mg a task name at themselve the second of t becausing a part were mery an entern every between of an 256 c, has again an almost a real metallicities and a second metalliciti

larger pro-m 2 , my set of the otherwise business to the

Pasterior of the second of the ben-ported or an above on hour and a second of the party above the the memories a major parent and a story without the fifty Agents who not have a first or a second of the true and time one office and inch another the tractivite at charles every as 1 , tractice ma, Ravaria.

## Albita-anorthite Series. Plagacciase Feldspore\*

The albite VaAlbuth and anorthite (Calibrith molecules are completery mise ble and together form an semiorph is series minging from the pure soda feedspar at one end to the pure that feedspar at the other and

<sup>&</sup>quot;The tredings (submass a thu were in at an ite to clearages \$ 010 and \$001 are Oblique to each rither are often raised in general plagnonum from ritoryon oblique

Techermak first established the isomorphous relations between these two molecules. A-ray study has shown an identity of structure throught it the series. The sodium and calcium at mas, on the one hand, and the make and abilitium a sous, on the other, may replace each other in the structure. Various hances are been given to innermis falling in certain positions in the isomorphous series. They are given below with the approximate range in carried positions of commonly assigned to each

	Albite Mo ecula	Amortante Molegule		
ALBITE	100 to 00 per cent	0 to 10 per cent		
( by I tree LASS:	80 to 70 per cent	10 to 30 per cent		
ANNENE	70 to 50 per cent	30 to 50 per cent		
I Charter's	50 to 30 per cent	50 to 70 per cent		
BYTOWNER	30 to 40 per cent	70 to 90 per cent		
ASORTHUE	10 to 0 per cent	90 ↔ 100 per cent		





Placewise with twinning lumefly. For S16 section is strong a centerner metric of high S1, order many against high S16 section in polarized light.

From all to to anorthite with the progressive change in composition (also specific gravity, melting points, etc.), there is also a corresponding charge an crystallographic form, and in certain fundamental optical properties.

Crystalline Form.—
The axial ratios and angles given on possible draw that these arielina followers approach arthorises a cosely in form the most attents difference from an the

clear age-angle be (010) A (001), which is 90° is orthodose. So 24' in abure, and 85° 50° in anorthite. There is also a change in the exist angle 5, which

and 55 50 m amorth to is 88° m albute, about 90° in oligodase and anderine, and 91° m amorth lits. This transition appears still more strikingly in the position of the "rhombic section," by which the twins according to the pericline law are united as explained below.

Twinning. — The plag celase feldspars are often winned in accordance with the Carlshal, 817 819

Fig. 817, rhombio excluse in alliste. Fig. 348, more the amortiste. Fig. 410 tv, at form as wrong a and exclusively-directions in a 600 and but the

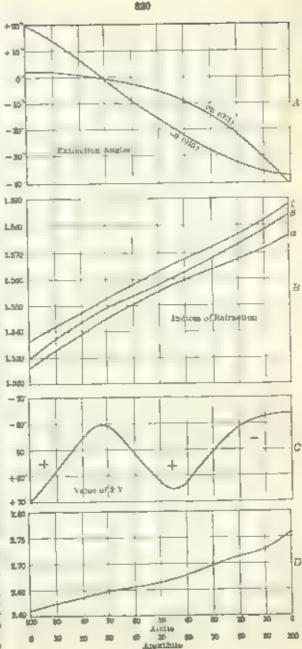
Baveno and Manesach laws common with or hickase (p. 530). Twinning is also almost an worsal according to the albite law - twinning plane the

brachypanacoid; this is usually polysynthetic, t.e., repeated in the form of thin la nelle, giving rise to fine structions on the larger cheavinge sur-Piece (Figs. 815, 816,.. Twanning to also common according to the law - twinsummers in tung axes the crystal axas b, when polysynthetie this gives another stres of the strations sees on the brackypinacotd

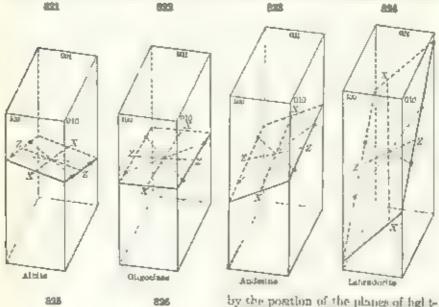
The congression plane on this personal team one of a class page of theoryte the er aga la such a direction on a terror or as with the separator have and the brain, many of the ed of the plant of the ed o article and the consequent does not the strictions on the muchy nuces cluster rapally with a second variation in the augie of In genern it may be easil to be n proximately parallel to the hage, at in all te this ma thogas hear's word + , Fuga. 8.7 and 8100 and in anorthdo to the front to Fig. 8.8 for the intermediate appeared its position variety progressively with the composition. Thus for the avertype magter between the trace of this plane on the trachyparametel and the edge b/c. we have for adute +25". I'v objection +6" for andespre 0 for laboratorite to, for bytownite -12", for aportifite 186

If the composition-plane is at right mades or nearly so to the based plung, as happens in the case of meetical to polysynthetic warnells then show prominently in a blane abotton together with those and to the abotton twinning. Hence the graving structure characteristic

of mucrocatar.



Optical Characters. — There is also a progressive change in the position of the  $\lambda$  and Z directions and a consequent change in position of the optic axial plane in passing from albite to anorthite. This is most simply exhibited



by the position of the planes of high typeration, as observe in sections partial to the two cleavages, has all and orachymmetods, but offer works the extraction-angle formed on each face with the edge bic of lags 819 and 820.4). Further the values of the inness of refract in discusse with the variation to composition from all to to anorth to this is shown graphically in Fig. 820.8.

The approximate positions of the optic axial planes for the different feldepars is shown in Figs 821-828. The Z direction always folks nearly in a pane normal to aftitude and a out, but the X direction varies widely in its position and hence the axial plane has an entirely different position in albite from what it has an anorthic

The axial angle, 2V, is always

large and its ago varies in different sections of the series, changing from positive with oblide to negative in algorithm-indexing, back again to positive it and ance-labradorite and once more negative in bytownite and anorthite. These variations are shown graphically in Fig 820C. Another property of

the plagiociase feldspars that varies with the composition is the specific gravity. This is illustrated in Fig. 820 D

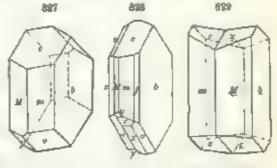
biliero In rock servicius the paracolase feldspars are distinguished by their cack of soint low refractive resert and low interference-colors, which is given exclusive remarks dark given and scarcete rise into white of the first order case by here broaded character in converging light. In the insports of cases, here easily tide by the parachel ban is or fine lanelles which pass through their, due to the main ple two uning accounting to be all itself wo one set of bands or two landles exhibite in general a inferent ordererence-color from the other of Figs. 815, 816. They are thus distinguished not only from quartz and enthoclase, with which they are often asserts all out from all the cummon rack making namerals. To destinguish the different species and sub-species from one another, as all stefrom laborations or an essue, is no reclude at In so, thou has ag a defined orientation and 6 fits. This can generally be done by determining the extinction angles of the and big all. In general is rock sections special methods are required, those are discussed in the various term devoted to the subject.

#### ALBITE.

Trichnic. Axes a:b:c=0.6335:1:0.5577;  $\alpha=94.3'$ ,  $\beta=116'' 39'$ ,  $\gamma=88'' 9'$ .

bc, 
$$016 \land 001 = 85^{\circ} 24^{\circ}$$
  
 $mM_{\star} 110 \land 110 = 50^{\circ} 14^{\circ}$   
 $km_{h} 010 \land 110 = 60^{\circ} 28^{\circ}$   
 $km_{h} 010 \land 110 = 60^{\circ} 28^{\circ}$   
 $km_{h} 000 \land 110 = 60^{\circ} 10^{\circ}$   
 $km_{h} 000 \land 110 = 60^{\circ} 10^{\circ}$   
 $km_{h} 000 \land 110 = 60^{\circ} 10^{\circ}$ 

Twins as with orthoclase, also very common, the tw. pl b(010), albute law (p. 542), usually contact-twins, and po-ysynthetic, consisting of thin lamella and with consequent fine structures on c(001).



(Fig. 830), twe axis b axis pericline law, contact-twins whose compositionface is the rhamble section (Figs. 817 and 832), often paysyn bette and showing fine structions which on b,010) are inclined

backward +22° to the edge b, c



Crystals often tabular | b 010), also clongated | b axis as in the variety periodic. Also massive, either lamelar or granular, the lamina often curved, sometimes divergent, granular varieties occasionady quite fine to ampalpathe

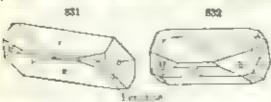
Cleavage c(001) perfect, b(010) somewhat less so, m 110) apperfect. It recture uneven to concludes. Britis H = 6.6.5 (s = 2.60.2.62 Luster vitreous, on a cleavage surface of an pearly. Co. it white also occusionally blush, gray, red. sh. greened, and green, sometimes having a blush spalese-new or pasy

of colors on c 00). Streak unconstell. Transparent to a bitmes acent. Optically,  $\tau$ . Let include-angle with edge  $b=\pm 3^\circ$  to  $2^\circ$  on r, and  $=\pm 20^\circ$  to  $18^\circ$  on b, Fig. 817). For position of ax ni plane six see Fig. 821. Despension for  $Bx_{si}$   $\rho < \nu$ , also inclined, horizoital.  $Bx_{si}$   $\rho > \nu$ , inclined,

crossed,  $\sigma = 1.525$   $\beta = 1.520$ ,  $\gamma = 1.536$   $2V = 70^{\circ}$  Bare(mi.general

weak,  $\gamma - \alpha = 0.011$ 

Comp A si case of during in and son um, Na Alberts or Natl Acta-68 5 = 87 cq 58 7, a unama 19 7 walt (1 8 = 100 Cal un a pa), s proceed in small amount, as morther thinking, and as the it trues



gr distractioned manage albite to oligoclase (cf. p. 547). Potassium may also be present, and it is then connected with anorthorloge and microchae

Ver Children to co. s. tale and hyperer the rese

they allodar 2 (00). The case of terms are on a finger's may will be a of The Course I are the transfer to a second of the second y y d y her reprise to be a se and the many of the second to NAZ E STEP E TO SET OF STANK IN DIGHT SE the transfer of the second of

The esc It is found to the above to the the state of the the contract of the second street of sites and second Name and the state of the state

of all it his partition was not be approximated is a lie form and the most may no get an a service etc.

\$125 of to charge

One the second of an agreement to be separated There is you a har a to be the service of the service a contract that he were tracked to the part of story a good The state of the s t record for the total or the terms and with me or a to a ser or other fit the country of the from hot agueous solutions. Also it is f and it besser traces a smale or gen for the first

the a very community is to any exempted and the special interesting for my one group in here he is if he interest to be an interest up at the total a color the color of the color the set of radio the thore be that the right is not the test effect of the first hand from the ergula street on I get whater to Make or all the other to fill or area In v. T. V. com, at Arm. in S. of Sec. 1. according Pringers of the land Sec. 2. A sec. 1. A sec. 2. A sec. 2. A sec. 3. A sec of the Pres Stem Corner Hear

and a sel states for yego at the of Mann at bolomy Americanagin for the et. At hereby to a train of New Has when he Was not a at Counter to I. Hampather C. in carried transfer remotivative in Connecticut at Mad-

547 BELSCATES

dam and Middletown Middletex Co., at Branchville, Fairfield Co. In New York at Macome and there and St. Lawrence Co., In Virginia, at the nava mass, car An gate of To see America Company of restalling to the Constant to the Penes Penes may be a few of the will get to prove and substantian to the through the Land Con Tenna. In the and to fine constant at Wheelman, Hawkings to On ario. I constant occurs to be that at the constant occurs to be a that at the constant occurs to the constant occ Lambert Co., C., 553ct.

The party were a terrived from alone, while in albusing to the centium color

Use "Artis as one is use and at expendionly six above decrees we are show an open except play of course what polither forms a part of the smanner at missene, known as Photograph in Co.

### THE INTERMEDIATE PLAGIOCLASE FELDSPARS OLIGOCLASE, ANDESINE, LABRADORITE, BYTOWNITE.

Since these do not constitute definite species but represent instead only perturn sections of the abute an other some replace series, it seems west to that then, logs her up for one headity

Trume For erystal constant a see table on p 535. The cicavage angles. between A cold are a gordina = 86 % statestine = 86 14 habradomie = 50° 4 , byte wrote = 55° 56 I winning as with albeit trystals not

contaron I sandy massive, cleavable, gradient or compact

Charages as in ashire H = 5.6 to = 2 to \$75 wee Fig 820/n Color white gray greenish versions, brown, relicient, at times each clear A play of er ors is a common character especially with certain alreal rates Blue and green are the presionament colors, but years has rest and part gray decognit. This effect has seen shown to be at least large, if the cities interference of high passed by reference from this another metro as of var as in nerals. These inclusions he paramet to bello or a a name nchassi at 15' to b Ameter with aventuring referts he area occur. Transparent to suftrangluciat. For the optical characters of the screense p 500 and Flys. 822-825.

For variations in composition see p. 542. A small percentage of the petrali fel spar in decide is very commently present also rarely the

barium feldspar molecule.

Fruitle to thus aplinters B II with mercusing difficulty owned the aporticle FWT . Etc. end of series. Insomble of shightly officially lift, the solutions increasing toward the

unorthate one).

more than is a common ruck making material, found expectedly in the more aculigneous notice as gracife, guess events, don't not be just haves, a local or or to ell mye comes like anciente this liste etc. It is somet miss associates with either one or gray to and entitles rucket. Notative world on fir its occurrence are in Aunt Agrics Nowly at You an and heart. If to us in the mass connections of the author is again as the variety as more at I reduced in the complete them of Standards of I (esty etc. In the interest of Standards of I (esty etc. In the interest of Standards of I (esty etc. In the interest of Standards of I (esty etc. In the interest of Standards of I (esty etc. In the I there is the I interest of the I in the I interest of th

Audence occurs to man's gravitar and volcanic torks. It is less entrance than objecclose and in especially characteristic of the rocks with meetings along our out. If a + is lound to the A design Marinato ( direction, as an eigens sent of the rock collect discrete, and is encourage to a service of the rock of the ro from the Mrs. A lamente struct of Trentons Study for brance it commends as stratons on a porph or in the resistant and of Saint-Maphael in the Lateres, Vac. Saint-Grand Commenter Maxes and or saint Angele Maxes and or saint An

Laboratorie is an executar constituent of various unicosa rocks, both philonic and relcan be the superior of the more hand types and stocks in according with mome member of the pyroxene or amphibole groups. Thus, it occurs in diames, gabbon, provide, andesite, baselt, etc. At times it is found in amphibolites. Such rocks are most common among the formations of the Archean era and are to be found a castern Canada, northern New York, Green and Norway, Sweden. Finland, etc. It seldom occurs to duefront cristian. These are however found in the adea of Monti Rosa on Erna in Sieny, in the quarte and sever of Vireepstak, northeast of Ahr Abdova Ne scalingers, Rubinna. It is to the in clearable inneses frequency showing the characteristic play of colors, at vary mus places, the must future being in eastern Labracar where it or are over a consideralso area in an anorthon a associated with formalence, hypersiliene, and magnetite. Also found as the area and Queber - It occurs abundancy through the central Administratorepron in no there best bork

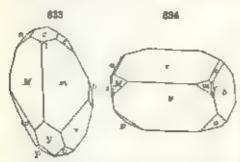
Hydro mate as ancomman occurring rarety in certain basic plutons; and vocanic rocks. It was originally described from Bytown, now Ottawa, Optamic. This occurrence has been

shown to be a must tre of anorthate with quarte, etc.

Use - The varieties showing a play of colors are used as ornamenta, material. MARKETTETE. In the rises and report grains in nectatorities, composition bear about durite. Probably represents a re-fused feldspar sather than an original game.

### ABORTHITE. Indiante.

Axes  $a \cdot b \cdot c = 0.6347 \cdot 1 \cdot 0.5501$ ,  $\alpha = 93^{\circ} 13'$ ,  $\beta = 115^{\circ} 551'$ , Tricking  $\gamma = 91^{\circ} 12$ 



Twins as with albite (p. 542 and p. 545) Crystala usually priamatio c axis (Fig. 833, also Fig 384, p. 164, less often elongared | b axis, tike pericane (Fig. Also massive, cleavable, with granular or coarse lameuar structure.

Cleavage: c(001) perfect, b(010) somewhat less so Fracture concheidal Brittle H = 6 6 5 G = 2 74-2 76 Color white, grayish, to a leveb.

reddah Streak uncolored Transparent to transluvent

Optically - For position of ax. pl see Fig \$28 Extinction-angles on c(001),  $40^\circ$  with edge b, c, on b(010),  $-38^\circ$  Fig. 810 p. 542 Dispersion  $\rho > \nu$ .  $2V = 77^\circ$   $\alpha = 1.575$ .  $\beta = 1.583$ .  $\gamma = 1.588$ . Burstingence

stronger than with albite

Comp. - A stheate of aluminum and calcium, CaAl-Sat), or CaO AlcO. 2Sit), = Silica 43.2, alumana 36.7, fime 20.1 = 100 Socia ne NaAlSist), 18 usually present in small amount, and as it mercases there is a gradual transibon through bytownite to labradonte. A small amount of KAIShO, usually present.

Ver Anorthus was described from the glassy crystals of Miss bornes, Venezius, and christianute and tunbuc are the same moveral. There are is the same town Ireland. Inchanne is a white gravish, or red his granular anorth to from In in where I occ as so the gangue of caren up, low feershed a 1802 by count Bourson of volume our re in small, transported an glassy everals, tahmar 60.10 costing coving in the delente of the Cycoopean Islands and near Treeza on Fina Lepotite, labobite also belong to anorthris-Amphadeiste and judgargate are satered aporthite.

Pyr., etc. - R B. fuses at 5 to a columns glass. Artificial apartitute fuses at 1550° C Anorth te from Mte. corms, and measure from the Camara, India, an decomposed by

hydrochloric acid, with reparation of gelatinous siles.

And. Another is the evaluat of the foliapare to be formed artifictable. Under the alkabir for layour t can be essent formed in a large of the evaluation to the components becomes progressive a more difficult as the allate replected in action to the components. As article as few laws to theorems in same of a really produced in article and magnitude. It further as a law post with a major of a really produced in article and magnitude. It

Obs. Anor late a charac cristica a continuity basic agreeds rocks, both volcation and putting as it applicates I such decrite, go brown controlled. If there is no his controlled use in an philosopher, I communicate a representational amount of controlled in the property of the property of the property in the property of the property

As off to recent at Venezia and collected tanks and on he is a constant of the second of the second

Awardate was anticot in 19% by Rose from models, oblique, the crystallization being

Anomouslite. A festinger having the composition bout 30 nO a Met 30 nD. This does not agree with an investile near our of the nature acceptance. This is explained by accepting the presence of all in the first acceptance at all in the first acceptance by the presence of all in the first acceptance at all in the first acceptance to the presence of th

## IL Metasilicates. RSiO.

Sals of Metaellion Ac.d,  $H_*SiO_4$ , characterized by an exygen ratio of  $2\cdot 1$  for silve a to bases. The Division closes with a to note of species, in part of sample of all of our position, forming a transition of the Orthogonates.

The met is realiss such le two prominen and we contracteries groups, viz the Pyroxene Group and the Ampubole Group. There are also others less important.

## Laucite Group. Isometric

In several respects league is alread to the species of the FELDMANN CHARD, which imprelately process

Leucite KAl(S<sub>2</sub>O<sub>2</sub>)', 1sometrie at 500° Paeudo-isometric at ordinary temperatures

Pollucite H. La, And SiOr), Isometric

LEUCITE. Amphigine.

Isometric at about  $600^\circ$  C , genulo-isometric under ordinary conditions (see p. 3.4). Commonly in crystals varying in angle Lat little from the trapsychedron n(21), sometimes with a(.00) and d(10) as subordinate forms. Faces often showing for structures due to twining Fig. 835). Also in disseminated grains, rais y massive grainality.

Cisavage d'110 vert imperfect Emeture concheidal Britile H = 5·5-6. G = 2·45·2·50 Luster vitreous. Cour white, sub-gray is snow e-gray. Streak unrolored Transfurent to opaque Ususay shows very

feeble double refraction  $\alpha = 1.508$ ,  $\gamma = 3.509$  (p. 331) I uder crossest means shows weaker orrefringent twitting bands

Comp. — KA SiO<sub>2</sub> $v_1$  or  $V_2$ O AgO,  $48aO_2$  = Silies 55:0, alternate 23.5, potash 21.5 = 400

to it is present only to small quantities unless as introduced by alternation times of fithium, also of tall that it will in this shows of tall that and above is at received the man and it will be fact that the two species can be can be can be can be to reach other when brailed with sometim or

Pyr, etc. BB of with, with cobalt solution gives a bloc color a manum. Decomposed by hydrochlane acid w door

gold a same a.

Diff Connectenced by its traperobodial form, absence of color and or it is a lit to softer than garnet and harder than and to the attention and fusca.

Micro heavy ted in this sections by its extremely low refer to section of the first suitage structured arrotatement to an experience etc. by Sel also Fig. 51.

2. Larger on the are consistently but which sections until further the construction of twining large rights.

the area pence a houseas, nerview and the count started my red of the first over The remains a continuous the quarter reporter plates and my red of the first over The remains are entirely ack that wanting or has a common are only to be distinguished from sometic or absorbe by chemical tosts.

536



Learnite crystans from the learnite of the Pearpaw Mis. Montana Pirson. These show the progressive growth from sketctur focus of complete crystans with glass inclusions.

Artif Levels is easily prepared art is ally by samply framing operator to construct in property on a larger of the second of property of the addition of property and the construction of the second on the construction and but the

were used togs for and also when to see a was figure same.

Obs. The reservoir seed of the reservoir and septembly in the recent layer, as one of the proofs as the reservoir and reservoir

Le este to a compositative y rare numeral letter prominent chieffs in the lawns of light and cert to competit a last of all of very last? More numeral, where it is think the number of the strength the first of grants and a large particle entitled also it she can ed the strength of the first of the first law to the cert of the strength of the streng

Magnet Cove near Hot Springs, Cortand Co., Arionists asphelits-orthodass-pseudotenests.

to the Loughte Hills to the Green River Bann, Wyoming to the Abserta's Range in the Yelconstone Purk, Wyoming, in the leighwood and Bearpaw Mis. Montana in part pseudo-lenerce. On the shores of Vancouver Island, British Columbia, where magnifecent groups of crystals have been found as and be store.

Named from Novice, civile, a salarous to be color. Polacette. Essentially 1167 A 240 A 451 ani O., Lannettic often in cuber also must over 11. = 6.5 G = 2.001. Color use. p = 1.525. Occurs very sprangly in the island. of Elba, with petaste (costorie) and al Rebron and Ramford, Maine.

Ussing i.e.  $-H^N s_2 AltSiU_4$  , Freding Three clearages  $C_1 = 2.5$  H = 6-7 Color reddash violet. In trees, 1.50-1.55. Easily family. Solve the major cond. Found in reactl masses from pegmatate at hangerdiagrade torseam I, also from Kola Penansala, Rossian Laplane.

## Pyrozene Group

## Orthorhombie, Monochnie, Tricknie

Composition for the most part that of a metasdicate, RSiO, with R = Ca,Mg,Fe chiefly, also Mn,Zn. Further RS:O2 with R Fe Al S:O4, less often containing alkahes (Na K), and then RSiO, with RAl(S O<sub>i</sub>), Rarely including arconain and titaniam, also flaoring

#### Orthorhombic Section

		42 () C
Enstatite	$M_MS_1O_3$	1 0308   1 , 6 5885
Brazite	(Mg Fe S O)	
Hypersthene	(Fe,Mg)SiO <sub>2</sub>	1 03 49 L + 0 5868

The positions of the a so the main size reveneed from the secon arthurhamble origination or order to complainte the minuarity of large petwern the offhorth most and about and ругозиания.

### Monoclinic Section

#### 0:0:0 1 0921 1 . 0 5893 Pyrozene MgStO<sub>2</sub> I. CLINDRINGTATUE

Intermediate between chinecustarite and dienerde 2 Property

ChMg(SiO<sub>i</sub>)<sub>r</sub> 3. Diopsiun 4. Hedensterre CarretSiOda

CaMg StOry with Mg FenAl, FenSite 5 ALGER

	fk.	a b	-	ig.
Acmite (Eginte)	Naka Sitta	1 0996 1	0.6012	73° 11
fadeite	Na Al Satis	1 105 - 1	0.613	72" 44,1
Spodumente	LaAliSiOna	1.1238 - 1	0.6355	59° 401

#### Triclinic Section

103° 18' 108° 44' 81° 29 1 0729 1 0 6213 Rhodonite MnSiO<sub>2</sub> Babingtonite (Ca, Fo, Ma)SiO, Foresta, 1 0691 . 1 0-6308 104° 214 108° 31′ 53° 34′

The Prioxier Guoup embraces a number of species which, while feiling m different systems - orthornombic, monochnic, and tricknic are yet closely related in form. Thus all have a fundamental prism with an angle of 93° and 87°, parallel to which there is more or iess distinct decayage. Further, the angles in other prominent zones show a considerable degree of amounty in composition the measurements of calcium, angressiam, and ferrous iron are

most prominent, while compounds of the form R(Al,Fe),SiO,, RALSiO), are

also important.

The atomic structure of the minoclinic pyroxenes, as shown by X-ray analysis, has the to awing characteristics. Each short atom has in the center of a catralaction with fear oxygen atoms at its points. These tetrahedral groups are inseed together into chains by the sharing of one oxygen atoms also between two adjacent groups; i.e., it each group two oxygen atoms also belong half to the groups on either side. This makes the shoots-oxygen rate equal State. These chains of all consexues tetrahedra at parallel to the vertical existing and are bound together intendity by the calcium and magnesium atoms. The magnesium atoms he within a group of six oxygen atoms while the calcium atoms are within a somewhat irregular group of each oxygen atoms. The prismatic cleavage of pyroxene takes place between the sali-on-oxygen chains.

The structure of the orthorhombic pyroxine, enstable, is similar to that of the monochuse pyroxine. The unit cell of enstable corresponds very crossly to two and cells of pyroxine arrived by their (100) faces, one the reflection of the that. The unit call gives an axial ratio in which the value of a lor bin his orients ton used) is twice that isolary given hach cell.

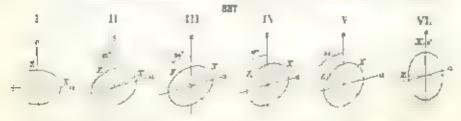
со ъядя видели поведея.

The species of the pyroxine group are closely related in composition to the corresponding species of an amphilistle group, which also endoaces members in the orthorhom, in, monochine, at I tricked systems. In a non-ber of cases the same claimed composited appears to each group, furthermore a change by parametrial series of pyroxine to amphibit a soften observed. In form also the two groups are related as shown in the anglitude of the parametrial of pyroxine grows to decrease and composition upon or about the of pyroxine (Fig. 487, p. 195). The axial ratios for the typical membeling species are.

Pyroxent a b c = 170921 . 1 . 0 5893  $\beta$  = 74° 10' Amphibole a b c = 1 1022 . 1 . 0 5875  $\beta$  = 73′ 58'

See further on p. 569.

The 42 cal real one of the prominent formbers of the Pyroxene Group, capacitans in report to the connection between the persons of the 4ther-axes and the crystall graphic axes are exemplated in the following figures (Cross)



I. Equalite, etc.

II, Clinoenstatite
V, Augue.

III, Diopeide. VI, Actiota, IV, Hedenbergite:

A corresponding exhibition of the pronuncat amphilians is given under that group, Fig. 864, p. 570.

#### Orthorhombic Section.

The orthorhombic pyroxenes castar to and typerstance form a continuous comparpholis series for which the namer steels that been proposed. Committee by our state a designated the March tend of the series namining makings up to those containing 15 per cent. If to be These are out as a personal The remainder of the series as picture, together and a known as by personal containing to the remainder of the series as picture, together and a known as by personal containing the containing t

#### ENSTATITE.

Orthorhombie. Axes 
$$a = 0.9702 \cdot 1 = 0.5710$$
, see also  $p = 551$ )

 $a_{23} = 10.0 \land 1.0 = 88 \land 6$ 
 $a_{34} = 0.03 = 41 \land 41$ 
 $a_{34} = 0.03 = 40 \land 41$ 

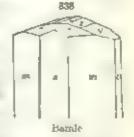
Prome range two pl \$1014) as twinning lampelled then two pl (101) has stellture twins crosse give angles of nearty 60° somet most exercised. Therefore,

erretale ram, haby promoter. I and a massive to

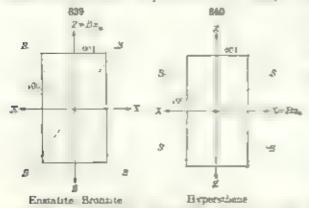
cir icture and relation to monatone pyre sense.

Cleaving m 110) rather east. Parting b(01) also a(100). Fracture uneven. Broken H = 45.

G n 3 1 3 3. Luster a at the pearly in cleavings-surfaces to virrous often mate, and the trackle virrous. Clear gravish, yet exist or gravish while to observe each and brown. Streek and dored, private. I materially opening Pleochrosen were marked in virrous est relatively not in the 1.0 to ally



+ Ax pl a 01) Bx, z = 001 of Fig 839. Inspersion g < z weak Axa, angle argument annable measuring with the interact of from using which the interact of from using which the interact of from using which the interaction of the second sec



MgSiO<sub>2</sub>),  $\alpha = 1.6607$ ,  $\beta = 1.6658$ ,  $\gamma = 1.6715$  (containing about 5 per centres)

Comp. — Mgrk(), or Mgrk(), or Mgrk(), a Su, ca 60 magr san 10 = 100 Practically a ways contains and grand formula, (Mg. Fr St), Treptrecutage of FeO present may vary up to about

tar the other or

lowest, gravious or green of white, more vitreous to nearly for a 10 % 3 % contains any profite of home where makes 4 % par a such Buch is an overcome being go here are a tree papers and 3 where occurring in the Donest mercene contain resettes of new good crystons, is summer.

2 Ferriferous Color gravish green is offeregroup and become Lister on cleavage surface of the polarity origin as a summand or broater-like as towards), this, however, is not summand. With the increase of trop passes to hyperother a containing the properties of a containing the properties of the pro

Pyr., etc. U.B. almost mustle, being only digitaly rounded on the thin edges,

has a lasoluble in hydrocha me and.

Artif — Enstable is formed from a melt having the proper composition at temperatures alight under 1100°. At higher temperatures the most alight under 1100° At higher temperatures the most alight of the property is appeared to the formed by fusing obvious with adica. When respective is mained it breaks flow atto enstablish and obvious.

Micro is the next one a color set or light vellow in green tracked renef prominent that he with the result to a separate set becoming the tipe with the result to a separate set becoming the set of the color of the set of

of conversal.

Ohs. I relative is a common constituent of those innerestrate that are low in percentages of an e and to a most essential of the analysis of an east of an experience of the analysis of an experience of the analysis of the

On me at the Edgar Berg in the Louisia Moravia of Crechesdovakia, in a serpentine like that a care premium, i.e. it in haraclas to be Moravia an character the manufacture of the interference in the Fightegeborge, Baronia on that a teach in the Radia, In a the Hara Min problement in he so that a late for the first in the Radia, In a the Hara Min problement in he so that is a late of the Dresse We her near the month belief the manufacture of manufacture in the factor of hyperstand hear fland to the name having in particular to mention also a strained personal and a strain a Bankerial, Norway In the section to the action of the harrier manufacture of the top to the particular manufacture of the harrier manufacture of the top to the particular manufacture of the top to the harrier manufacture of the top to the particular of the part

In the United Notice of New York at the True Forest councility name. Brewster Putname 4 - a. Edwards of Lawrence to the Penney seems at Tenna Laurence Co., at Bure Hills near dark more Maryana in North Candida at Webster Jackson Co.

hard troto oracres at a smert been as a release at The name bronate has

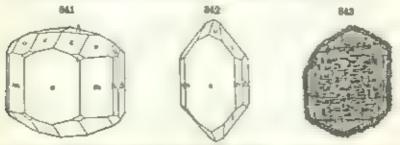
priority but a broase laster is not essential, and is far from any versal.

#### HYPERSTHEAR.

Orthorhombie. Axes a . b . c = 0.9713 + 0.5704 (see also p. 551)

mm 110  $\wedge$  170  $\Rightarrow$  88° 20° or 111  $\wedge$  171 = 52° 23° A4°, 0.4  $\wedge$  174  $\Rightarrow$  16° 14°, or , 242°  $\wedge$  232°  $\Rightarrow$  75° 50°

Crystals rare habit prismatic, often tabular a(100), less often b(010). Usually foliated massive sometimes in embedded aphenical forms



Figs. 841 Amblystegus Lancher See; 842, Milnia 843, Beetinn million showing inclusions the exterior transformed to automotic; from Laurenz

Cleavage m(110) distinct, parting b 010) good, of 100 rare. Fracture uneven. Brittle, H. = 5-6. G. = 340-350. Luster somewhat pearly

on a cleavage-surface, and sometimes metalloidal. Color dark brownan green, grayish olack greenish blues, puchbeck-trewn Bireak gravish. browtish gray. Translucent to nearly opaque. Pleuetrousm riter straig, especially in the kinds with high from perceptage. Thus A or class browtish red ) or b axis red ish yet w. / or c axis green. Optically - Ax pt 6 t.0 Br. 1 a 100) Dispersion a > v Axial angle rather large and variable directaining with increase of iron, of eastable, p. 3.3. and I am 849, 840, p. 553 Indiago for variety with about 15 per cent first), a = 1 6-2.  $\beta = 1.702, \gamma = 1.705.$ 

Reperthene often encloses mitute talaçar scales, usually of a brown color arranged ments part of to the case plane I g by also seem from a received of a re- of the cases they say be intended goodly a horse as a strong trace a creat are the name of the per diar me a mailable or of orbiter and are often of ore of part origin being accesoped along the so-casted "mo dion-plante" p. 211.

Comp. - (Fe Mg/SiO), with FeO greater than 15 per cent Aluenta as communes present top to 10 per cent, and the extaposation than approximates to the aluminous pyroxenes.

Pyr., etc. B.B. funes to a black enamel and on charcon yields a magnet in coforms more easily with increasing amount of iron. Partially incompared by the control SHIP!

Migro. - In this pertugue airclar to envisible except aliant delimit red too or given ish

enter with attrouger pleasing about and is outstably

he age to ensure to which me

His erstness seconded so b a firefule feldquar, abendonte, is a sometimen certail gran dar gors in riche as to inte hy sente galder no l'instruction e la blue te despression authorité à la contratte de la contratte d manufactor as It were in transmitted in make where these existent I as a provenience to make the fighter over an even for

Hisperschesse openies in large invistals with print and te at Bodersman. Browning at visit on by the per to the property of the property of the period o and applicate is from the andreste of Aranger Perg near Poke on the Misson if True v within of it as star.

In the Laster States it occurs in New York in the quinter of the Coctian fill region or the Holler Rapid and in the Amendment region. In the applement of Haffalo , each, Earle ......

this make and of Mr. Shouta in worthern is form at

ply an above in termine from very and whose very strong or lough

the repeated of meaning as. At others earlied to in here to have no appear make've the state of the intercept of the state of t was green beints near Haraburg in the Blaza Min Community, also from a stream in the be his prest furtures

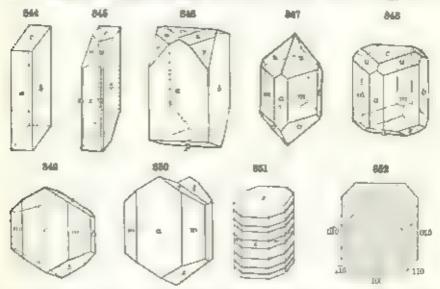
Fr. 1. And Pr. 2 Mg Fe (StO), (Mg Fe Set). Occasion is considered mediates in the meteoristic of basher ale, harmet Co., Louis, May 10, 1979. Co. - o. St. Color light givernate. and

#### PYROXENE.

#### Monoclinic Section.

Monoelime	Axes a	h c =	1.0921 1 0 5	$5893  B = 74^{\circ} 10^{\circ}$
PTT FFR	110 ^ 170	- 92° 50		001 A 221 = 49 T
co)	001 - 100	= 24 D		00a Ja0 v 7 1
CL	005 A TO			001 1 1 1 - 6 .
ee	ari A offi	- 8 B		12 y [1 - 18 50
Et.	051 V 051	= 97 11		[ 1 4 [[] 2 ] 1 ]
and a	BUL A 1EL	a 33 46	00 .	221 ∧ 221 - 84 11

Twins tw pl (1) a(100) contact-twins, common (Fig 850) consettines polysynthetic (2 c(001) as twining lameter producing structures on the vertical faces and pseudocleavage or parting ((001) Fig 851), very common, often secondary 3 y(101) cruciform-twins, not common (Fig 4.77 p. 193) 4 W 122) the vertical axes crossing at angles of nearly 60°, sometimes repeated as a axerayed star Fig. 476, p. 193. Crystals usually prismatic in habit often short and thick, and either a square prism (a(100), b(010, pronuncat) of nearly square 93°, 87°) with w(110) predominating; some

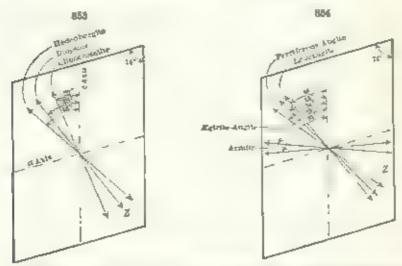


times a hearly symmetrical 8-aded prism with a, b, m (Fig. 851). Often coarsely lamellar a 101, or a 100. Also granular, coarse or fine rarely fibrous at equipment.

therage will sometimes rather perfect, but interrupted often only observed in then sections 1 c into thing \$52. Parting a 1001, her to twinting, often prominent especially in large crystals and hard har masses (Fig \$51. also a 100 less distinct and not so common. Practice that he is to go harding. Bristle H s > 6. G = 3.2 5 to varying with the composite to Laster various inclining to resinous of the dim sometimes pearly a tall in an its showing parting. Our mandly green formous idlations is, a rather to brown and chick rate y origin green, as a kindle or attaining charming, also thus Streak what is gray in I gravesh green transported to opinion. Please to be streak what is gray in I gravesh green transported to opinion. Please to be partially weak even a dark-containing man in a coshrown kinds containing man in (I tolaids is unine given to a length pleaselment variety from the Caucasas Mis.)

Optically = Borstragence weigh,  $\gamma = \alpha = 0.02 - 0.03$  Ax plusically b = 0.00 Bx, or Z = 0.03 in displace, to a = 52 in angels (which see or Z = 0.01 = 20 to  $30^\circ$ , the highest general nervasing with amount of iron. For  $L_1$  pands  $2V = 59^\circ$   $\alpha = 1.664$ ,  $\beta = 1.6715$ ,  $\gamma = 1.694$ 

Comp. — For the most part a normal metasilicate, RSiO<sub>3</sub>, chiefly of calcium and magnesium also from less often manganese and and The alkah metals potass in and sometim present carely except in very small amount. Also in certain varieties containing the crivalent metals aluminam, ferric from, and manganese. These last varieties may be most simply considered as n olecular compounds of the Mg, Fe SiO<sub>3</sub> and Mg, Fe (Al Fe SiO<sub>3</sub>), as suggested by Techerolak. The mains is sometimes present in small amount, also transmit replacing silicon.



The name parameter is from each fire and here, stranger and records thany a new that the interval sens, to be expressed to the expressed to the content of fire whereas, in fact to at next to the for imports the most universal constituent of species make.

The car are are numerous and lepeno upon various as a composition cheefly, the

soore protesties of the varieties properly mark as sub-species.

I Chromostative MgesOs. Study of artificial crystals show that they are monochaic and either tabular after 100 or prisocate after 110) and always congeted parallel to the cases. Polycombatic twinning on a 100) very characters are. Good prisinatic cleavage at 85 5′. Colorless to ye like Ax. pt.  $\pm$  6.010.  $Z \wedge c$  axis = 22° see Fig. 837.  $a \approx 1.651$   $\beta = 1.661$ ,  $\gamma = 1.660$ .  $2\lambda = 53^{\circ}.30$ . Composition varies with iron replacing magnesium and grades into what has been called chuck specificae. An increasing percent ago of sech as accompanied with a rise in value of success and of the extinction angle,  $Z \wedge c$  axis.

MgSiO<sub>2</sub> can be erestabled from a most having the theoretical con-position at about 1500°C or at a lower tem continue from solution in master case as or magnesium variables to be from continued from of MgSiO<sub>3</sub>. It has unitros menung point but at 1557°C breaks down into foresterite and allow.

Clinoc istatite occurs rarely in igneous rocks and motocrites. Clinohyperathene is known only in meleorites.

2. Progenitive. Intermediate between chaoenstatite and diopside, a maxture of the molecules. Mg Fe \$105 and CaMg \$1055; A so near compacing may occur in the series between chapenstatite and heden ergite. General payment properties also also follopse to Ax pa 1 (0.0 in varieties low in lane of anging 6 010 at a content of 7 to 10 per cent Car). Axia, angle small and variable. Optically + Z A c axis varies from 22 to 45° inereasing with ann control. George at various points in diabase, basain, gashro etc. Namest from occurrence at Pigeon Point, M. it conta

3. Property M. haconte, Alabie Calcium-mannes um instrume Formula Cally Score = 51 ca 55 6, here 259, magnesta 18 5 = 100. Coor white yellowish, grayish white to pale green, and from to dark green and nest y black sometimes transparent and coloriess, also rarely a fine blue he presume a crystals often septler also granular and community and element massive  $G = 3.2 \cdot 3.38$ .  $Z = r \cos = +36^{\circ} \cos 40^{\circ}$  For indices see a nove from as present usually to small agoe not as noted below and the amount

increases as it graduates toward thie hedenbergite

The following beautiful Cheams-do pards, contains chromaum 1 to 28 per cent Cr.O., often a braz it green

biqueotite, as originally described, was a pale-colored translucent variety from Sava.

Sweden

Aceste occurs a broad right angled presue, colution to fain greenah or clear green, from the Massa Ap of the An valer Pastman, Italy

Proceeding from I reversely Predicate I taly is similar I wan a a line thought from at Marcel, Piedmant, Italy, occurring in principle prystals and massive.

Comparate is a grayish white or bluids white pyroxene occurring with dominite at

Canaca, Convectors

Largerite is a 15 to xune, colored green by variations, from the neighborhood of Lake Harks in section in section

Manginer is a 0 a nuc-benning precious composed buyets of the diorects and houseberg: a moter des oes rount at contact instamorphia himesione from Mana,6 Manutana parent of Lane Hillsingland, north ora Sweeten.

though was annued from our new make and offer, upper rance. Maintable to from

makasor, soft, because softer than fermiour with which it was associated

4 HEDENBERGITE Calcium-won purexone Formula CaFe(Sit), = Silica 48 4, tron protoxide 29 4 time 22 2 = 100 Color hack In crystals, and also lamellar massive  $\Omega = 3.5 \cdot 3.58 \quad Z \land c \quad \alpha_{xis} = +40^{\circ} \text{ to } 48^{\circ}$ α = 1739, β = 1745, γ = 1757 Manganese is present in manganhedenbergile to 6.5 per cent. Color grayish green. G. = 3.55.

Between the two extremes characte and beleabergite there are a margin transitions cent on ag so the formula the My Po box to As the amount of your nevented the color changes from ght to dark green to seam; black the specific gravity parceases from 32 to 3 6, ap 1 the angle Z A c axis also from 16 to 48.

The following are varieties can up under these two subspectes, leased in part upon

structure a part on pre-carities of company on but to Sahi, to one graving green to keep green and black sometimes graving and vellowed white in excelle abouter our quarting (00) of grante masser longfrom Lake Statust in Siberia.

Cognitive a a grant man variety on hed had its calcite, also forming loggery coherent to compact aggregation, other war, any from white to pure green to lark cive, and then containing consideration from the latter the original coccuste. Notice from among a great Distance it. A smellar or the off offed pyroxene "barneteered by a fine lamellar."

structure or I part up a 100 west some porting will up this often a 001 Asso a librous structure uses Terranage a litt often posycycline a ateriaaningtoon with an orthophombre pyroxene common. Color grayash green to tought great-green and deep green also between Leaster of surface of 100 when pearly, succeitings metalloidal or exhibd ag schiller and recentions from the transite presence of married out of amount are order or given by A = 4.39 to  $40^{\circ}$  A = 1.081 p = 2 = 24023 H = 4 G = 3.243 35. In composition past dispude, but offer containing also me and compression in remaiders in amount ther proper to be cleared with he angree titler changed to and haver see an wagther and realter p 574 Samer and Sulkars, different o all de mor so the desair or panes of fracture. This is the characteristic pyre sear of galbro, and other resided rocks.

Omphante. The granular to foliated previous constituent of the garnet rock called eriogite often interismonated with amphitiole emeragine color gran-green. Contains

some Ald).

Scheppenere. A manganese pyronene, cometimes also containing much gon. Color brown to black

In creatale, sometimes tabular - 701 also with p-101 prominent, more often elongoted in the direction of the sone ( 013 p 101 marris prisons); said. Take, with of 100 as two pt very common Age existance massive freezest profit all year darking Color yellowish brown to revisib brown as black revisible even spreads 4 Z raris = 44 25' The respect effects from his erg, barriers is bears a rest and has Z A c ame - 414' to but for different some to be same or stall. The bears row schoffente abande from Lingtonstation, Sweden, has Z 1 c and - 10"3 It resembles garnet in appearance

Infferential is a manganese-nuc privage from Franchis Furnace New Jersey but the zinc may be lim to puparty. In ange coarse criefting still edges propided and faces un-

even ( what greenal have on the expect surface the counce his win.

Blanforder A for some contain of some soil in manga me and the principle pleochrour rose-tank to say him. Found with manganese ares a the central Promoss,

5. APOSTE. Aluminous pyrozone. Composition chiefly Ca MgSi O, with (Mg Fe A. Fe Sath, and occasionady also containing disables and then graduating toward acriste. There are sometimes present. There are vinous explanations of the composition of the pyroxenes containing the sesquioxides, their exact character must still be considered as unsettled. Here belong:

a Larray term. Color white or grayish. Contains alumina, with time and magnesia, and it do not not not. Laries size dioparts.  $Z \wedge c$  axis  $z + 40^\circ$  to  $45^\circ$  H z = 6.3, G = 3.19. Named from Acases, where

b. Essective. In finite the pair to dark, experimen deep-green creatals, or pastachinprocess and then recent ing epo the The Mathabetas hards of displayer acre but my later.

Support from the server of the formate. There is properly from an accuse a port

a tourn maining the greenest a brownish his Land big A L as occurring mostly be en or to cocks. It is small a short promise transle, the site of takeour a life, often to us him he had been drained acre promise a reader that a stronger trains a determined to the same transless to a life to the same transless to a life to the same transless transless to the same transless tran When make a transmit at the out her most inductor provening I is give the year or metdish F - browning tee, or vessel Z - greenish yellow, reddish, or visitely engij, kuster

d. Empire-at time Here beyong varieties of augite characterized by the presence of allegest, especially state, providing to the even of the sometime or are, but event "X A class - 54 " 45 For the lasthe percentage of the all the thouse ar I make there is an encrosse in the deriver of 25 and a the error tion a shift and street at

orb in alliabies, as outstate over to place obtain out the ote

Principle Variety and important and analysis a composition in the information and office and office and analysis and a few and and the information and a few and give with the three one way by regarder. Must varieties are may ed spently soule Diff. Characterised to re-new an creatable store on the prior of a stiger of \$7 and 93°, bence yielding nearly square prisms, these may be mustaken or scapeant if terminal

faces are wanting or indistinct that scapplito faces easily B B, with intersective! The of pie parting a color, Fig. 55 i often custing tree, also be cut that did green to gray on on an enter. An philode infers a prismatic angle bid and find an entervage, and in mixing common columns to throws varieties, which are rare with pyraneus. See also

p. 571 }

Micro. — The common rock forming pyroxenes are that it guided in this sections by their high reach small greeness to an entropy of our first of section of intermitted cless agout a few manners at near right angles in our one is a walk by \$4.1 high interference was general ack of termitted large (x) and interference are general ack of termitted large (x) are reach programmed by she way the lightest transference of the view of the angle of options for our veryor light on having purallel that the characteristics of the vertical axis, were also

regirite, p. 361.

A notes become is common, the successive latenter constraints differing in set on angle and provider also the none-glass error, are occasionally street by \$50 from Laurence.

After — Purkens argues aftern' in in different ways. A change of mole ar rouse taken with a cases a change of compaction is to account of some figure with rather to alive as the first of a far formation of some appearance for philade. The take we to provide of an and, a monotopy of a philade. The take we to provide extended are often manged on the extended to treatment similarly with other varieties of many localities, here wishes, p. 5.4. Also changed to stantify surprise for our call.

Oha Pyrotene is a very common impress in greeous rocks, being the most important of the formanagroups markets. Some rocks consist all nest

entirely of proposed. It was common a scarce is common rows in the and mon. It was a such as a section with degreeated noun. It is a case mon amount on create the limitations and in a material particle of the analysis of the virus large body or visits especially a few large rows in the state of the virus large body of the section of the virus large body of the virus large body of the virus large of the section of the virus large of the virus large of the large of the virus large of the large of the virus large of the control of the control of the control of the control of the description of the rows large of the control of the

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about the appropriate to the event of the etc.

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an Alpe in Camithia, Austria. From various points near Rol in the Fichtelig-targe. Pavaria. Schofferer & from Linghambyttan Verman, Swelen and from Jacousters in the York-

much townet, Vermine t

A spire occurs in Bobenia of Czechoeleraties in fine crystals in basett tuff at Borestan southeast of Tenner Toront. In Law in he Lemede An tent M name, Valid: Lama, It south of feare for Verse is green to we. . . who we care we se from Pargas in Lands to Posts and a Norwa at the in a 1 st-Ag or

he the lines make the at periods who as no he a newes discovers are at Common in Landing Continues of any or the sage to read you a Mangarity was writing in the expansion maps to are a to any in and it is not experient to be got by the steaming on the form of the same and a form of the same of the first first in Distraction of the Marie and and are a limit of the areast are erestas who can be an ele a most as our Barries in figure var, or Lowis at Indian who can be a created in a lawrence (c., a the half or monado; me of the sectional based of see Parameter for the least at least the sees of the parameter of the section of the large of the section of the the practic rangers in the Hann as in mile

Printene the first formula at only one at the Arrberts of Queber and beautic expe-tant a compact to with he are a deposit a the Queber and discount formula to believe Co. white creates as in the contract the mode Co. In matter at various process of their new Co. will apartite, titurate, etc. to Lanara Co., at Ba hurst, experiess it vinte crystma, and at North Burgons.

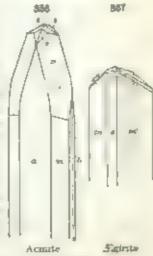
### ACMITE. FRIENTS.

Monoclaric Axes a 5 c = 10096 1 06012 p = 73° 11°

Twins: tw. pl. c(100 very contains crys as a carps ser there, with encosed twinning lamenes. Crossule tong presented vertically streated or channeled are e terminations very characteristic

The above applies to ordinary acroite. For equate gradule presumer 14 maily terms and of twee out common, also in grape which of stender account a common, eventually action in historical format.

Cleavage m(110) distinct 5-010 less so Fracture uneven Br to H = 6.05 G = 3 of 3 55. Laster corrects, inclining to readous Stream pale yellow an gray Color brownish or reddish brown, green in the fracture black so green Subtratisparent to opaque. Optically Ax pl 6000: X A c axis at various small angles, usually about 5° (see Fig. \$37) a = 1 776 5 = 1819 y = 1830 on artificial material ( snally strongly preaching in colors of brown, velow, and given with absorption X > Y > Z21 large Highhed dispersion, p > o large on in composition by the in rudget on of the diopartic and hedenbergste in lecules most fies the optical character. With decreasing content of the acmite molecule the refractive indices, the dispermon, and the birefragence decrease hariations in the values of 21 and extraction angle also occur



Var Includes accents in sharp-pointed creatals . Fig. 856, often twins. Also approxi-(Fig. 857) in crystais beauty terminated, twins rare.

Comp I seem by Note See, or Na<sub>2</sub>O Feets 48(0) = 8then 52:0 from second 34 8, and a 13:4 = 100.

The government of the state of

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Micro Egyptic is character and in this sertions his to grow gives relief strong please the sound for the sound to the soun

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### JADRITE.

Memory and Axes a biox 1003 1 0 613 B 72' 444' for ally property is better the structure sound new granteger also becarry collected the form of the structure o

the relieur is the state of the first of the purpose of the state of t

Comp. Fast a first and distribution of the street of the s

Chlorometorate is a dark green to nearly black kind of jadnite thence the mane), containand come areas of box a real of structure setting a contract of the area and do person contracting

yot astacked by acida Pyr., etc. UR new read , to a transparent blebby good.

after famou, as I this offereig from assessment

The prestion of the cognition is betribution of judgets proved great difficulties. It are been suggested and the presents a loop-smaled outside which of up come rocks that the so the reply conventes and phonolises. It occurs shortly in eastern Asia, thus pear Tawnay in My taxon of I pper ft rous, where it is associated with a scripe to a that has been herived from an alwans once. It also comes from T be used from the greaters of Yingtipe it somehern China. It is also reported from New Zealand and from Mexico. Much supertainty prevaid, however as to the exact lacanties of occurrence, as most of its sources are in little-explored regions and because of the frequent confusion between judities and nephrite.

langute has usus been bugbly priced in the brent repectally in China, where I is worked into omargents and totals of great arrety and beauty. It is now found with the relica of early to up these or the remains of the lake-dwellers of Switzersite), at various public is

France, in Mexico Greece Patytel, and Ama Mour

Use - As to represent pade, is used as an attaneously stone. See before Juck is a general term used to orbite various moseral enteractes of beigh, compact texture out these winter to cook green out a used by early man for decision or foremental, at a still backey wallers or the Foot, especially in bour It in ones properly two sizes in

one organical a serious of at ph. sort p 374 makes trouvoute or act the with 6 = 205 30 and patent of he provides group, with 6 = 35 1 15 case i mills

The pade of these belongs to both species, so also that of the "wise lower-hall-battons and of Merico. Of the wo however the former capture with more common on a sheatthe pain ax stone or Pump en g of or Mauris of New Zeemer and Copier to Aleska

The same pade is the sometimes were about the distance what the group of there is treat structure therefore, and while have been or pugitable and only speed them submanute, propurely a series of seriest as The "lack school of

de riscon, re is now souled assistante.

## SPODUMENE. Irtphane.

Monoclime Ases a b : c = 1:1238 : 1 : 0:6355.

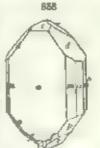
 $\beta = 69^{\circ} 40^{\circ}$ 

Twins tw pl a(100) Crystals prismatic

(mm ' 110 \ 110 = 93 9' , often flattened | a(100); the vertical plates strated and farewed, crystan sometimes very large.

Also massive, cleavable

Cleavage m(110) perfect. lame, lar structure a(100) sometus en very prominent a crystal tuen separating auto this place Frag ure uneven to subconchor-H = 65-7. G. dal. Brittle. # A 13 3 20 Laster vitrouse, on converge surfaces some west Hantagion Mass. I pura Directation of Spodgravish white, velowish green,





with a city

emers degreen, yellow amethystine purple. Streak white-Transparent to trans need. Physchrosm, strong in deep green varieurs. Optically + Ax pl bio.0,  $Z \wedge c$  axis =  $r 26^\circ$  Dispersion p < p.  $21 = 54^\circ$  to  $69^\circ$  $\alpha = 1.05 \cdot 1.60 \quad \beta = 1.06 - 1.67, \ \gamma = 1.675 \cdot 1.68.$ 

Holgeride has a veiler great to entered green wire, the latter variety is used as a gent In among to I decrees hing member constitute constant was often exched

Kungste in a close libre-colored variety found near Pala San Diago Co. California, and else as Vaccatarata Managawar. The maltered material from Branchville, Connecticut, shows the same color I see as a gen stone.

Comp. LaAl(SiO<sub>13</sub> or LaO Al<sub>2</sub>O<sub>2</sub>4SiO<sub>2</sub> = Silica 64.5, alumina 27.4, lithis 54 = 100. Generally contains a little sodium, the variety hiddenito also chromium to which the color may be due

Pyr., etc. B is becomes white and opaque swells up, impacts a purple-red color filther , the time a west tree or mill and a sad from a local car or while glam. And so set you a name to an dish as a neigh many or with an orange punk over whom extented by an equivating electric discharge by antra-visible rays, X cays, or rad computions.

Diff I was texted by an exfect parting in 100 in some varieties as well as by print or election up has a higher specific great a and more pearly inter than festigar of

mare to live a red flavor is B. Lone on a chigh an a gon c

Also and between a constant or a good or a for the term of a with those on a good to be larger to a as a constant Latera, and a for the terms. the galaction of the . " or or of production after a first a larger to the arms." I do read and don't for it artise and or over it have an a more than one a way or aporte reasonable mater. These interations print in to are were also we in the operations from Brown are Conserved.

Artif At art a su a set prome has been eld amed together with other alle ates by form grangement has the marks in the control of a Transport etter a flexibilities of the form of the control of as the term of groundstated is transference to the p mountestion on now heating

65 F ROT C

Obe. Sportumene occurs to grante pegnat for sometimes in cristian of very great ent. It is to the part of it water to be a broader at he or our conful library count of the part of the each of a veg at on of the agreement in a manner.

The first and grown a state of the best of arms build be been a state of the best of the b were and a second of the secon posses a way to the terminal for any order of the second of the control of the second the experiments we cannot a to the contract of Ban thego to, at Mana rate a lana, much seem and in Revenue to at Cabinea, etc.

#### Triclinse Section

The following the line species are comodered by some anthors to be digitated from the pyroximus and to form a separate group by themselves.

#### REODONITE.

Trichite: Axes  $a - b = a = 1.07285 + 0.6213 = a = 103^{\circ} + 18$ ,  $\beta = 108^{\circ}$ 

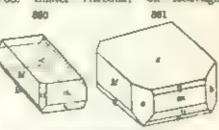
44'; y = 81° 39'.

Crystain assuits large and rough with roun led origen. Commonly tabular cub, sepretures rescubing pyroxene in laber Come may massive, charalle to compact and to embedded grains ( restals from brankin. New Jursey, above possynthetic twinting, with ( 00)) as twinning plane.

> $mM + 0 \stackrel{?}{=} 170 = 93^{\circ} 254$   $m = 01 \qquad 37 = 7 = 2$  m = 1 = 0.2 = 23ab. 190 - 010 - 94 26 or (1 K - 1 Se) by 221 / 32, - 91' 6' am. 100 1 110 - 45 33

Cleavage: m(110), M(110) perfect c(001) less perfect. Bustamile shows perfect cleavage | 10101 | Fracture conchoidal to aneven very tough when compact H = 55-65 G = 3 + 3-68. Luster vitreous, on cleavage

surfaces somewhat pearly Color light brownish red, flesh-red, rosepink sometimes greenish or vellowish, when impure often t ack outsi te from exposure. Streak white, Transparent to translucent. Option by  $+ \alpha r = 2V = 76^{\circ} \alpha =$  $1.72 \cdot 1.73, \beta = 1.73 \cdot 1.74, \gamma = 1.73$ 1744 Bustomite has 2V = 44°;  $\alpha = 1.66 \quad \beta = 1.67, \ \gamma = 1.676, \ \text{ms.}$ pl and X nearly 1 to (010



Franklin Furnace, N. J.

Comp. Manganese metasilicate, MnSiO<sub>2</sub> or MnOSiO<sub>2</sub> = Silica 45-9, manganese protoxide 54 l = 100 Calcium appears to be always present and may be a necessary constituent. It has been suggested that the formula might be written (a Min Sol), a Bustamite has much more calculate than ordinary moderate the material from Franklin New Jersey has the composition Callin Silly. It was differe from those once in its opised properties. There is avidence that there is a continuous series from rhodotiste to bustainite with a gradual change in the optical properties. Forderite is a various with pine replacing manganese

Pyr., etc. - BB blackens and face with slight intercorrect at 2.5, with the foursgiven from some for the grature. I'm ente given with which on charmon a room up for Sightly action of an in the case forms warreties often offerprises for the distance. men at re if cult in earthwante. It promiter part a tomor on us his recharge as used to unclaime part on comes of a white traor. Darkens on exposure to the sit, and sometions becomes nearly 1.

Diff bursers sed by its pink color, distinct cleavages, hardness, fundancy and

manganess may though It B.

Obs. the limits core in various mangation one hodge, (request a sucretated with short abmedia atc. It can as a he haven any destrict of he I ad Miss where the Sees to passage and so has for structure to a represent meta tetraliseante as hope is a south at racers. In Italy at a case a Mannetonia for I menors, from Foliance of A. f. are an other on Italy or in the result. I merely us Language should not be the

I make the same for the account to a same from Broken H.H. New South Moles for Teres Not the fields Moses and of Manisch metta, and some of the neighbor git with the same to be a same to be a same to be same t distance a rest. I is use it a state along the a country assessment in a standard rystate sa-

Names from polar acres on its month to be when Which is to profess a want or it to warm in it the Mint on a married an education, dynamic, also to be statute accompanie, according etc. further by is traduction of (1), always, phot his etc.

Ithodonite at times is used as an ornamental stone

Pyroximangite A transact, managementon pyroxime In closwage manus. Closwages 1.0 and 30 and series of in breed 27.176 H = 5.7 to the close angles to durk series based of faither to accomplish during the series of the complete globale. After to accomplish the complete series of the complete series

Babingtomic that is Anderson to South are not black the new crystals may be shown to a suggestance of the Charages of and 10 also 000 at the call and 10 also 000 at the c Names, from haveno in Lag Maggore, I communt, Italy Francis in contact crystals at

Arendal in Aust-Agrier, Norway in the United States in Massachusetts from Somerville M di lesex Co., and at Athor, Worcester Co. In New Jersey in the scotte deposits of Pas-

Sobralize — (Ma,Fr,Ca Mg SiO<sub>n</sub> A tricanic pyroxete: Pratastic cleavages: G = 3.5 fe- wa rolor: 21 = 4, a = 1.74 Options; + From cascate rock in Soders

material Sweden

Wollastonite, pectolite etc have until recently been commonly placed in the Pyr sens Group to which they have certain remaining, but because of definite gryst-mographic structural, and optical differences it is better to separate them from the more typical members of the group

## WOLLASTONITE. Tabular Spar.

Managhme Axes  $a \cdot b$ ,  $c = 1.0531 \cdot 1 + 0.9676 \cdot \beta = 84°30'$ 

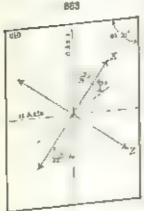
$$mr^{H'}$$
,  $110 \land 110 = 92^{\circ} 42^{\circ}$ ,  $60 \land 101 = 40^{\circ} 3^{\circ}$ ,  $86^{H'}$ ,  $840 \land 840 = 70^{\circ} 88^{\circ}$ ,  $67 \land 001 \land 201 = 74^{\circ} 50^{\circ}$ ,  $49 \land 011 \land 201 = 87^{\circ} 5$ ,  $67 \land 001 \land 104 = 45^{\circ} 5$ 

Twons (w pl a 100) Crystale commonly tabular at (00) or at 001), also ris re-presentate. Usually elemented massive to fibrous, fibers parallel or reticulated, also compact. A-ray study shows a

structure make that of diopside but with a simi-

arity to that of rhodomte

883 ni. Diama, N. Y.



Dollan Chept I Land of Wollacti arte.

Cleavage: a(100) perfect; also a 001); t(101) less so Fracture uneven. Britile B = 4 5-5. G = 28-2.9. Luster vitreous, on cleavage surfaces pearly. Ca or white, menning to gray, yellow red or brown. Street, whate Subtrasspurent to translatent Optionly . Ax pl bt(1), and o the usual direction of clongation of the crystols.  $1 \land c$  gaps =  $32^{e}$  in the acute angle B Depertuon  $\rho > \epsilon$ , included distinct,  $2V = 40^{\circ}$ .  $\alpha = 1.616$ ,  $\beta = 1.629$ ,  $\gamma = 1.631$  artificial materiad)

Comp. Calcium metasaicate, CaSiOs or CaO.  $SiO_4 = Sihen 51.7$ , lime 48.3 = 100.

Synthetic experiments show that well astorate our take into who where up to be percent of the cooperin molee de la Coper ent of the alterpar de tholorque and also D molecule having the composer on Mat 2Mgt 6860, It The terr - I see home with at me moreones. When wellingtonite is heated above 1200° C. it develops a

term, e.e. sugge areas are lober govern of the part of non-new a transfer a to a distribution in This material has

here saled are note a for a feet a to a whose, a report place.

Pyricate. If It does not a feeting wors with separate place a Water I, from the a feeting wors with a free, the glance. Water I, from me a decouple was want separapresident at control to the special resource

Micro . It if a wetpoint a lab once is courted with a modern e rehal and medicall " gence. The plane of the type after is account corting to the enorgation of the CCS a

Williams to may be obtained art fixed viby testing a glass of the composition Artif C + r (persons 800 at 1000 This is stable to 200 C At higher temperatures the rises to you get make and to other in detailed

Obs. Williams, were a see as a contact unnered to crystalline hunglinese formed by the or tain of any class consider 1 contents, common as a the parameter of contexauters and at a comparatively low temperature - its occurrence in countrie ricks is due to the nature of disks at a constant of the occurrence of the state of

all the training and the training of the property of the prope I a me a secret of a secret with a secret of the secret of a second must and at Patient to Turner in I was one one of the respected most be at 1 to become Mean

to the United States in New York of W. Aleman Assess of in Lewis Co. at Diana occar No drive to the Co. at Diana occar No drive to the Revenue Co. Manager, a per compet co, a tropped test breeze Eversion Co. In about a Company of the a regarded to all the original orders to

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To be have seen as the discount of the signal of t strong of a 1447 per cutt, and the bound the transfer the transfer the transfer the transfer that the transfer the transfer that the trans

#### PECTOLITE.

Moreover Axes  $a \cdot b \cdot c = 11140 + 0.9864 + 8 = 84^{\circ} 40'$ 

t only only in close aggregations of across receivable managered burns,

to rare a terminated. Fit yets the man attention at

Cleavage a 100 and cold pasters from the pre- pract | British H = 5 G = 2"4 258 I ster t the survey direct region or a laureous Color wheast or greatst. Sub-rays rear to opening Orto 1 + 12 pl and  $Z \perp b + 11 = A \text{ reary } \pm a_{0},00 = 21 = 60 = a = 1.95, \beta = 1.900$  $\gamma = 19633$ 

Comp. HN at a<sub>2</sub> S<sub>3</sub>O | or H<sub>3</sub>O N<sub>2</sub>O 4C<sub>8</sub>O 68:O<sub>8</sub> = 8 nea 54.2, and 33.8,

mata 9 3, water 2.7 = 100.

The amount of water present corner collected at the all in extent of the research at the above forgital Port to me or their common to the firm of the leaves have Mag or on may be present as a far your y, do sond and transpances, as of many (Military of Athenty Co.

Per ole - I there was the man water BR Famount I to a white emaped. Decon twent a fact of his con- no activity injuries in of a case a july of feet go as out

highly wife a become a the rich

Obs. Less like on the and the year test of an existing of segme in larger eye taken more to a que to a pay ago a support to the above to an another than the The action of the service of the ser

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Selected to the selection of the selecti

cars very specially in the amphibhes or its reg is or the largence thord as seen here

Newsy to urphelite-sympto porpoyry Had H.J. Moultophore, Carrell Co., Now Hings a whate

The change, relationably of the filtering rare minerals are supertain the first two have been considered as a relation of the a propaga taking

Wöhlerite - A tirestic posible estado suate of the Nagele Monoclicar of the accounts to the tenth of Martin Carroll Co., New Hampshire.

Lavende. A see for the second of the Carete containing and F. Tarete. 8 'ht an -, m = 170-178, Found on the mland Lives of the Langue protogre on home or ment and neighborhood or from Brane and the Los intends, France or not be Are-

Congritute It at the Emeritary Nanta S Ar le with him florence Trichine is pure, section to indicate the creation for the continuous for

## 3. Amphibole Group

# Orthorhombie, Monocame, Tricame

Composit on for the most part past that of a metasheste RSO, with R = Ca. Me be charry, also Mr Nos Kells. Further often contain og a unimum and forme men. The composition in the case of some ampoints es is very complex with extensive representation taking place between the different elemerta. It is in press blo even to ast here he different theseed as this bave been proposed to account for the year does in compact to become however, the atomice a re- use of the an il dioles has been investigated by V-ray enert ods twee p 534 and form a as suggested that confirm both to these faces and to the election or point on. The type in section or derived by Warren is faint to have a most ox gen read of Side materal of the metaman attempt and and a Hotel to fact or that is one before the man or time It at her of oxyget a come or their or its alrate scalws - twenty for a light the ten beruf the agriss a store, or the engage between agreement the the attend atoms no of record eight to equilat and the a great releasing processes and the state that your latwice the and three the governit forms he restorming to sever the in respections to the king Mg. Fr , Fr , Al, I to the , Aspect of Off Free Hart milk restore it a field to Berman and Larsen to the following ( ) No Y Mg Mg t) . 1 See Such woll by a while with a may re, an Mg and Al a particly It the expect it and stoly be an honeyer, no object method out forth has been one the on at every me ground the court of funtament the expostions of the different and day of the group. Futer day member of the compositions of each will be found in the succeeding pages.

Orthorbombic Section

0.5137 (

	Monochuic Section a : b : a
Amphibole	0:5511:1:0-2938 73°58'
1. 2. Cummingtoner 3. Grunerte 4. Turn dute 5. A tundure 6. Itourer te 7. Hounderse	MgStO <sub>1</sub> (Mg Ferst O <sub>1</sub> (Fe,Mg,StO <sub>2</sub> CaMg,StO <sub>3</sub> CaMg,Ferr,StO <sub>3</sub> ) <sub>4</sub> (Kr,Na <sub>2</sub> ,Mg,Ca,Mn,StO <sub>2</sub>
fiderate Pargnato Carmon horableade Busaltic n-ribbleade	Contain to lecules approximating to the fol- owing a varying properties (in Mg Fe Scal) — Ca Mg (Al Fe Scal) NaA.St b :
Glaucophane Na(A. Fettsk()	-

	, Mg, FeiSiO <sub>5</sub>	0.58 1 , 0.30	(0,
Riebeckite	Nabassion with FeSiO,	0:5475 : 1 : 0 2295	76° 10'
Hastingsite	CasNa Fe Mg (Al Fe)(OH)	AlSi iOm	
Arfvedsomte	NasFe, AltOH «SuO»	0.5496 : 1 : 0.2975	75° 44'

#### Triclinic Section

## Enigmatite (Fe Name (S. TitO, Na(Al, Fe) SiO<sub>2</sub>)<sub>1</sub>

The only species included under the trichine section is the rare and imperfectly known magnitude (consyrite)

The Astronomy Group embraces a number of species which while falling in different evenesse are yet closely related in form — as shown in the count on premium exercises of 54° to 56°— also in of total characters and closely relation. As arready moved occup 552—the species of this group form elembered a series parallel to that of the closely a loc. Pyroxeas total plant tween them there is a most relationship in crystaline form and other characters. The Amphibole Group, however is less fully developed, including fewer species, and have known show are variety in forto.

The chief districtions between pure-term and an obtain a prosper are if a following strainable regard with province a No. 3,000 to within a district an and last, the profitable change them to be set to the after

yields a program, resolves usually all it proposition in I of representative structure of temperature and temperature of a non-second structure and the stru

for ple do a man and then a manife her la the rate

The specific gravity of most of the jets approximate at higher than if the like varieties of applitude. In community of corresponding mode, agreement is approximate a figure 1 to a purely, -1 if to these to a katter more frequency pany a presument part in amplitudes.

X-ray study has shown the structural relationships that exist between the pyroxene and amplitude groups. The amplitude situature can be lerived by a reflection of the pyroxene structure, ver the plane 010. This results in giving a unit cell for implied to which agrees with their of pyroxene except in the dimension parallel to the blank. This is twice the value of the corresponding dimension of the pyroxene cell. In pyrixene as stated on p. 552, the stheon-oxygen tetrahedral groups are arranged in single chains parallel.

to the c axis, whereas in amphibole the sur thr groups are united into double chains. These tasts account for the crystall graphic differences between he two groups, as it dustante the inflorence between the respective electrage angles burther the groung of two succit-oxygen chains together reduces the stare not xygen ratio to \$131 instead of \$35; as in pyroxene. The poest one of the memory and magnesson at him to the structure are summar to then two out of the pyroxene some ire, see p. 552

The of and rentions of the prominer mainless of the group, as regards the position of a receives, is as the oil by the fed wing figures Cross : compare Fig 837 p 552, for a satisfar representation for the corresponding

members of the pyroxene group.

Orthorhombic Section

## ANTHOPHYLLITE.

Or corhomics. Axial rate a = 0.5137 + 0.000 for battle pare habit premay e mo. 110 A 110 = 54 23' for wanty mechan, or face acatasave

fibers of en very slender in augregations of prisms

that ge pramatic perior han 1 se so, a 100 semetimes distinct H = 55 6. G = 285 32 meresons who perconsiges of sept the cr vitre is, sugar what prory on the convage free Colir brownsh grid, volumen brewn, class-brown brownst green superabl-green superimes metal again Stronk uncerted or gravel Transparent to subtransacent for the gleechree, Y = Y = r w st Z = pale yellow-green. At pa | b(010). Z = c exis. 2\ nears = 0, weal. + it inthe, by life, - its geding. For an final MgSada of = 1 a84, 5 = 1 a97, he variets with 27 per cent before x = 1 tass, x = 1.612, y = 1.657, for larger percentages of FeSiO<sub>3.7</sub> may rise to 1.698

Comp . Mg [ See corresponding a custoffe-bypersthere in the There is to some reads in in option, therefore between in a physic +) and gedrice -, as between instable and opers one of lags 839, 840,

n. 553,

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Budrous anthomisphiling have been repeated y described, but in tonet cases they have been shown to be hed, ted months, a 3d what Pyr etc. If it foses a cl. off it, to a burk traggretic quantel with the fluxes gives

rear one for from; upnated upon by soids

Micro. In sections countess, non-prescience Parallel extraction Commonly Blatowasi

A thoph this is formed artificially when magnesium metast ate is hiertest Artif

considerable along a such any such area from quite, something

Obs. Above, by the sit of the counts are sold at three becoming the chief constituent of the rock. It as on upto to have up to view decided county the metal orpl. san of ar some we are near bangetery, Nowa, from Jorna while a Morning of a section uses and at D recones user have a on the Done to we have a F and in they considered in soul term I remaind to one on a the United States in Pennsylvania in Luday are violent in National and the of Prance in Marie violent

The original gestions is from the the or H is asset to ones that on Produces, brance. Similar anthough H. as are used observed in Norway at Bandos in Telemark, at Sharum

in backeres, and a treathering.

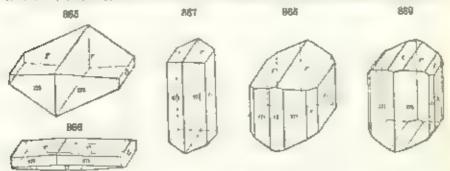
Named from authorage is clare, in adoption to the elementary color

### Monoclinic Section

### AMPHIBOLE. Homblenda

Monoclinic. Axes  $a : b \in = 0.5511 : 1 : 0.2938; \beta = 73° 58'.$ 

Twies (1) by pl a 100), common as contact-twins, rarely polysym-(2) c. (001), as two samelies, occasionally producing a parting managents thene

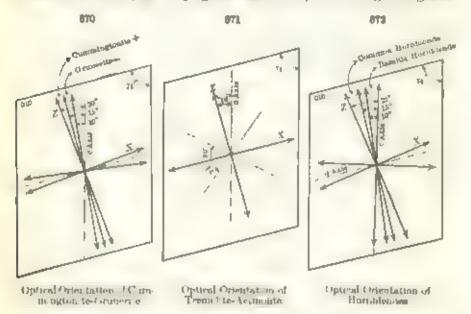


to that more common with pyrosene Fig. 287 p. 1951. Cryst is commonly prismatic, usually terroir sted by the low chardonic rittle, ser strais by r and p. 101 regionly developed and then suggesting it, unto hedral forms that Also cor union or fairous course or fata, libers out to like flax, of tournachine) ravely hunefly also grander messave, coarse or har, and usually strongly coherent, but cometimes iriable.

The result flographic position here a liquid in that auggested by Tachera ak, which best ext I be the real and between uniterabile and personning. Some authors or any too former pose inn, second sig to which p = 301 , r = [11] etc.

Cleavage: m 110) highly perfect, a(100), b(010) sometimes distinct Fracture a bean lorded, moven Brittle II = 5 6 to = 29 3 f 5 rving with the composition. Luster vitreous to pearly on cleavage faces, fibrous varieties often silky. Color between black and white, through various shades of green, inchning to back an green, also dark brown, rarely yellow, pink, rose-red. Streak uncolored or paler than color. Sometimes nearly transparent unusary subtransacent to chaque.

Piecehroson strongly marked in all the deeply colored varieties, as described beyond. Absorption usually Z>1>X. Optically -, rare  $y+\Delta x$  plusually b(010). Extinction single on b(010), or  $Z\wedge c$  axis  $=+15^\circ$  to  $15^\circ$  in most cases, but varying from about 1° up to  $37^\circ$ , higher angles in



rare instances. Hence also  $Bx_{\infty} \wedge c$  axis  $\approx -75^{\circ}$  to  $-72^{\circ}$ , etc. See Figs. 870-872. Dispersion  $\rho < \nu$ . Axial angles variable, see beyond.

Options character, part to only increase of reference. himselvings of and extinction angles wars with charge in a inquestion, part orders with the Lotal amount of our crossest. In general, he conserve and extinction angles increase with increase of iron content while the hirstrogenus decreases.

Comp. — In part near to a normal metasilicate of calcium and magnesium, RSiO<sub>1</sub>, usually with iron, also mangatiese and thus in general analogous to the pyroxenes. As stated on p. 508 the silente oxygen ratio corresponds to Si<sub>2</sub>O<sub>2</sub>, instead of Si<sub>2</sub>O<sub>3</sub>. The algorithm metals, solding and potassium, also present, and in re-commonly so than with pyroxene. In part also aluminous, corresponding to the aluminous pyroxenes. Trianium sometimes is present and also rarely theories in small amount. Water is considered as an essential constituent.

The problem of the communition of the amphiboles is a complex one and has been the object of much endry. Extensive replacements of one element by sin ther may sake place, giving rise to a wide variation of the composition. It is impossible to enmounted here the various interpretations of the composition that have been offered in the past or

even to indicate all the views that different moneralogies hold at present. See p. 569 and further the let the different various described below

1 MgSiO<sub>1</sub> An amplishede of this composition and corresponding to elinoenstative of the Pyraxene Group is of doubtful natural occurrence. It has, however, been prepared artificially. It would form the theoretical end number of the various and bibble series in which the molecules besuO<sub>4</sub>, MnSiO<sub>5</sub>, and CaSiO<sub>5</sub> appear in us more hous relations.

2 Cumprisonovers (Mg Fe,S.O., The magnesium and from replace each other in varying amounts and the numeral grades into grower to Small amounts of manganese may be present. The range in composition of the cumum agrants grants be across strong about 70 per cent MgS O<sub>4</sub> and 30 per cent besinh to nearly 100 per cent besinh. The name community restricted to that portion of the series containing increase 50 and 70 per cent MgSoO<sub>4</sub>. Usually blue is in filter-amount of the rails and (a varies from about 3 a to 3.5 for grunning in the continuous Z  $\wedge$  class = 20° to 15° decreasing with mercase in percentages of best O<sub>5</sub>. Optically + 23 large  $\rho < \nu$ . Indees for samply equal maxtures of MgSoO<sub>5</sub> and best O<sub>5</sub> are  $\rho < \nu$ . Indees for ramply equal maxtures of MgSoO<sub>5</sub> and best O<sub>5</sub> are  $\rho < \nu$ . Indees for ramply equal maxtures of MgSoO<sub>5</sub> and best O<sub>5</sub> are  $\rho < \nu$ . Indees for ramply equal maxtures of MgSoO<sub>5</sub> and best O<sub>5</sub> are centages of iron

3 Guerrary Granerite the Mg/Sith. The percentages of FoSith, range from 50 to 100 per ren). Mix50 h may also be present in cross derivate amounts. See firstly under cumum geomete, above. Commonly fibrous or lametar G=3+3 f. Court brown. Siky luner.  $Z \wedge c$  axis = 15° to 10°, decreasing with increase in percentage of Fissith. Optically  $\sim 2V$  args. p>v  $\alpha=1680$ ,  $\mu\approx1.707$   $\gamma=1.726$  (for pare 1.800). The values decrease regularly with receasing percentages of the main in least the presence of manginum represents the args changes algebra the indices.

Axial angle large

I magnetic. Grammatite, nephrite in part Calcium-magnetican amplebate. Formula has count only been given as CaMgara,  $O_{2}$  but from a study of the atomic structure by means of  $\lambda$  rays it is so we that the composition is more accurately given by the formula CasMg, Office  $a_{1}$  as Ferrolla from occurs replicing the magnetium, tremolite their grading into activative. Small size of other reolecules involving alkalies may also be present. Colors whate to dark gray. In distinct crystials, either long-baded or more rarely short and stout. In aggregates long and thin color mar, or fibrous, also compact granular measure nephrite, below.  $G = 2.9 \pm 3.2$  Scinctures transparent and coloriess. Optically Extinction-angle on b (11), or  $Z \wedge c$  axis  $= +16^{\circ}$  to  $18^{\circ}$ , hence  $B_{12} + c$  axis  $= -74^{\circ}$  to  $-72^{\circ}$ .  $2V = 80^{\circ}$  to  $88^{\circ}$ . a = 1.60, b = 1.61,  $\gamma = 1.62$  for nearly pure translate,

the values increasing with increase of the acumolite molecule.

Prepull to was named by Pica from he Tremon valley on the south side of the St. 4 46 -ET 1 3H 4

It is to is the name given to a time amphibule near tremule a from the manganess minor of Central mana.

5. ACTIVITYE Cale uni-magnesium-tron angle hole Formula Ca-(Mg, Fer. 111 - S), Or The quant of the iron is equit, Unite, Olf q (5.4) sy, var ex probablyona 1 tand 30 per cent of the utal Abrahas also somet mes present the shall an ourts. Color leight green and gray st green. In translated out of closes or large a left, as in treme to be cultanuar or formula. gran dar substace to \$ 4.02 Separation transported. The wines in last tast green crys saw rated gates, according to crystals break casely across the green the hir as and todated and have from called ashest form or transfer of a continued occurrence. Actual to owes its green color to the ferrous (ron bresent.

The shorest cost act in crossing as the amount force increases and Prince the city of the states, Zer eruld-grown I via swegger i. A greenish ye low Also re on Z > 1 > Y, Zi erta Of the ly France consange (B 6 010 , / c ax + > +15 and By, Ac axis + 75 21 = 78". p ( a = 1014, d = 1 a), y = 104 (for variety w h about 20 per cent

of Iron molecule).

Somes with a to be an a trong and today above a transaction of the Corrasa Strait.

after a subject on him original as to enter him a to be a recording

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the original pyroxime is that corresponding to the a fference existing between the two spaces to greater, that is, as meaning in he regress to had be reason a call to The clarge, there are near some a great in parameter and in the great seattle to the temperature of the continuence of t was the full operation by figure a rose for the language It has suppressed from I may not need. The manuscript of the a pump has shown on , were if " er a surtion" or expense, and some . . . re regard many horntageness make and so, we to represent a tured protects for its as a surge scale

6 RECEIVED An amphibole containing MgO 18 to 21 per cent), Cat) ,5 to 8 per cent), MnO (5 to 13 per cent , alkali oxides 5 to 9 per cen ,

In charge edersatals, addonous terminated to = THE topes of the velocity researed. Transmission is substituted to the terminated to = THE topes of the terminated to = THE topes of the terminated to = THE topes of the topes of the terminated to = THE topes of the to Lat greater turn that we critical by the presence of mangament, and alamos in results ofly

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7 ALLMINOTS AMERICIAN Hornblende Centens al in us or ferre tron, and use illy both with ferrome from secret meaning over in ghost to eal is in, and advance. Hyoroxy and flagram the contractly present it mostly and the and it about it then y a rich so The a ratios of hard here a here and doll range from the light-on-particles te, routs angle life ripon around the light to dirk green pargar tr, to the dark edered or black 6 and an a the color growing darker with increase in an emit I rate in x a transition variety from 0° to 37, see below. Procepositisting. Absorptive anally X < Y < Z.

Pinguing Almonous Supremer Calesian Am Whole Coder where a green and risto From a property of the second of the second

the Russian mineralogist, von Robiliarov.
Courses clear to the Paris of Colors or ght or duck grown, as I to sub-grown to green and the short and the second se ther the their associate, at the term of t

Fig. 6, a sent Pargue by any a to see given unity ground touck erver in Zinc

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palmocharoutes.

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furnishing a described as an amphibuse atermenate between breathends and glaure-

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L. marks re ... and an rice to meeting of Chitario and Queber. Artificities is found in Hallburton Co., Ontario. Black homblande we was any a late, sea in the cine at the are as he estress to Orders at rectain A ger of Chiefee admise Astronton and mountain cork are found at Buckingham, Ontawa Co., Quenec.

### GLAUCOPHANE.

Monocante near amphibole in form Crystals prismatic in habit, usually

inder net community massive, him us, or col most to granular

Cleavage mor10 periect bracture conchosts, to uneven Brittle. H = 6 05 G = 3 3 15 Luster vitreous to peurly Color agure-blue, laven ler-tilue, black grayan Streak gravish blue Translucent Plachresso strong a marked Z say buy to alternarioe-blue, I reduish or brush viset, A or ica sliggeen to coorden. Absorption Z > F > A Op-Ax p h (10 Z A c axis = 4 to 6 , rarely higher values. It was matrong p < c a = 1 fill B = 1 fest, y = 1 fills  $2V = 4V^{\circ}$ 

Comp. Lecentually Na, Al, Fee St(Og), with Mg, he St(Og) in varying pro-

mertions.

Paradogurarechane described as similar to gia couphane but with an in termina to 1010 there is a reading a track of glasserphane it a quarter chain the brain and also in a erystalling schiat fr Sw. are and

Other in regulation as I sale as a count time of metamorphic rocks as glasco-phases has to reason at oning a second towards on. These was his about me and by one second place of enther ground or reasons on means. It is associated a though

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1 the linited States glaucophane rocks are found over a large area in the Coast Hange

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a neither e-ster te, we thesat of one Warter French Espasional trees.

#### DISRECTITE.

Monochure Axes 1 b c = 0.5475 1 0.2295 8 - 76° 10' In embedded prismatic crystals, congitudinally streated. Clear age. prismatic (56.) perfect H = 4. G = 34. Luster vitreous Color dark blue to black 2) large Strongly prochable X = dark Luc, Y = blue or greenish to thrown at well- a / = ye low green to dark green. p = 1603, S = 1605, y = 1 607 | Insperse h hariced

Comp. Essentia y Vale Satt, soth FoSet in varying propertions It corresponds closely to account segurity among the pyrenears

Obs. Ingreals used med from the grant to and syent c of the along of soccess. he Tomas Amo. 120 a Na elsa et rom topoetter al Mary al a l do no programme to a compare to the And run graver a state to the transfer of the latter than the latter than the state of the state a town to argo reach the cast not about Amounts and Iteporton was from the I'r thee of Kano, Northern Naperta.

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#### AREVEDSONITE.

Moreover Ages a  $b \in \mathbb{R} \ 0.5490 + 0.2975 \ f = 75^{\circ} 44'$ 

Can halve long prosing often by our hellor, he seems hadredly terms mated that we hear to see of an phalode, also to position to aggregates. The has Other land

there are presente, perfect both less perfect fracture aneven Broke H = b C = 8 44 + 45 Lister v recos Celor pure block in than somes deep green streak deep to also grav. Upaque except in this

sprinters. Pleachrosen strongly marked Z = greenish yellow to allo-gray; Y a avender-blue to I rounish ye, ow, X = greenst the Operally As placemed to (1.0) Axial angle, argo  $\alpha = 1.687$   $\beta = 1.707$ ,  $\gamma =$ 1708 Example on 5 010, vous 1 A caxis from 14° to + 20°

Comp. A sight violate met solution of solution and ferrous from chiefly with smaller am that of alumnom and ferrit from Nuberl OH Shop

Pyr, etc. B B has at 1 with in an assessment to a lack magnetic globale, concrette finite die a main with the faxes gives read tone for from and management. Not noted

Micro In then sections shows brown or gray green of gray violet colors strongly

presentation to be seen a green, the tent to the parameter.

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is or over much from Norway appears to be I termed to between a few one to at tear. herring ZA mans a sout to the Interpretary 1 - Z > 1 - man from 1 respective I reme I rem had an green was brown Z - reclaimly or greeness a show an are such late way, or greenth blue. Optically -

Issue 1979, a files on search book from Karront I managed at the Greenley I

The bear a way by for a 1 so the sold set of most by provide the first series by most by the first series by most of the first series by most of the first series by the first series of t In large crystals at Lugar, Ayralure, Son --- I

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Writing a scurpt. Perhaps Na Melte, Lesify their lander of appear of agengates of remaining from a frank const. From a meteoric pro- at Conjuit and, I and I fin.

#### BERYL.

Hexagonal, Axis c = 0.4989.

Very stray of the structure one was but he vertical axis of the and rel has a value twice magrees or home. The core is as a proof to on or age of a a paint w lying at the posits of tetrahecta. The tetrahectal gire ps are unless together by the cluring of croygen atoms into rings, having the composition Sight. These sides rings are joined there by atoms in a summer group of the creater of a group, of an everyor atoms and by buryon about in a summer group of their caygen atoms. There are two nationals in each area. CALL

Crystals usually long present to often stricted vertically, rarely transversely, distinct terminations exceptions. Occasionally in large masses, coarse columnar or granular to compact

$$ep$$
,  $0001 \land 1011 = 29 - 581$   $ea$ ,  $0001 \land 1121 = 44° 56$   $ep$ ,  $000, \land 122 = 26° 31$   $ep$   $-1011 \land 0011 = 28° 544$ 

Cleavage, c(000) imperfect and indistinct, rarely shows imperfect pristance chavage. Fracture conchesion to meven. Brutle. H = 75 & C = 2 0.1 2 80 usvally 2 69 2 70 Laster vitreous, some unes residous. Colors emerglo-greet, pole green, passing auto light blue, we low and white; also page rose-red Streak whote Transparent to sub-rensourcet Lachrossin more or less disting. Optionly Birefraguage low. Often abnormally based. Indices vary with the presence of alliances, \u00f3 = 1 565- $1.002, \cdot = 1.564 - 1.595.$ 



Var - 1 however Color large to merald given the to the presence of a little chro-

tulips highly present as a generative common tree from flows

2 cred way to at the energy in manage is contact of the course and larger, green the the program, a gree table on to not vellen in I have all we accord an earlier of the program in the price of a popular of the program in the price of a popular of the program of while gree of calculations and a popular of the program of while gree of calculations at the program of the progr but reservabled powers in amountal colored suppliers.

Comp. Be Al. SiO<sub>2</sub>), or 3BeO Al<sub>2</sub>O<sub>1</sub> 6SiO<sub>2</sub> = States 67 O<sub>2</sub> alumina 19 O<sub>3</sub> glucius 14.0 = 100.

Alkaline South Last, Carly are sometimes present repositing tan berylliam, from 025 to 5 per a 1 and the ment's constanted water, and tag which the forming becomes that the 230 cb b

Pyr, etc. It B show unchanged or if clear becomes milky white and cho fed, at a lagh temperature or regre are a miled, and ultimately a vasic dar scores is furnished brighter - 5 and somewhat nower for betale me it address to me with borna, must and e-derless or bery a one green for expended. I cacted a sup in gradu.

Deff. Characterized by its green, it greenish have color going taster and hexagonal force carely in mance between manthers or quarte 1 as y the rim apathe to barchese not song sent until a heate one are et thing group a simulation from character. bend to inform from encourage and one by the so perior real engine

Artif I from most differs have been produced artificially by fasting a maxture of affice,

planting and gliques with bord oxide as a flax.

Obs. - Beryl is most commonly found in growth rocks, either in drivers in the grande or is programate come. It has now been nearly in turn one has a th tensor such as a so him a. The emergials comes a taken done over the next as more for sear one, a maque type

of a control

on it was not not and to a the rine superior took tes run be mendioned there I was no see to be in a figure or or a side or or or a see support of the contract of the to a return or by settle on the loop in . I lt. come londer our will send of the state of the state of the third country From the last the second of th Amongabe and Man I am a get Maria M he own open, Man busing Salimitivotry . Hen of the respect to select a respect to the respect to t Sing a risk or It had not be too automorphy and not be by all ore its ble no mil a sore, Calord

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MUHHANTE. A litamum-airconium militate of sodnito, iron, manganess, and carriers. In tabular consect. We now as then upon I small the vicint of = 1 (35), H = 2 d From La Jays and Hillma testimes, how principals, northern Hama.

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terminers. And the Albert Spire 1140? Orthorne mit I gustians from with the start of the resign II 5. Tourne a surface tall again team into Vogtland district, Sammy

The two factoring minerals are very similar to each other and should possibly be conmideres no sur sum se

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Didymante — 20 at 1 to 1 to 2. More in the sea of ned creatal film 4 5 . - . "I to a tark gray type in the fact to the season that the found so contact temperate in mentions from Interka River, Yes some Interfact, to come

### CORDIERITE. Inlite. Dichroite.

Opthorhombie Axes a b c = 0.5871 + 0.5585 X ray grady of structure infrastes possibility of health and a symmetry

I wins two plon(110), also do 130, both yielding peculio-hexagonal forms.

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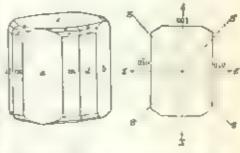
Habit abort prepartie orm" = 60° 50'; (Fig. 877). As embedded grains;

tion makers, compact

Change 5 010 distinct, at 100) and a 001 indistinct. Crystals often show that at at protince or 00.1, especially when slightly altered brack-re-

subscript and Britis II = 7 7-5. G. = 2.60-2.68. Lauster vitreous. Color various shades of blue, light or dark, emoky blue. Transcarred to translugent. Ple che -m strongly marked except in this are one Absention Y > Z > X. Y = dark violet, blue,or brown, Z = clear blue, X = Calcult at 100

Preset, roje his ever mmon, often I right team has been in sections coon fixt to de dimine enigures. Optically -. Has also been



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Comp. Mg-MS(O). This is the one associated artificial motor a that has the manufers of corlecte. The pater declared engages for the role replacing a part of the magnesium, careful and hydroxyl are assuption in

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bon dioxide, or the introduction of exide of non-proof alkalies, forming pints and mice. The first step in the change is successful to the period of the interperiod of the interperiod of the change in the interperiod of the interperiod the terms are the a people of their properties of the terms of the ter as a fer from A a. T. mile, a Pertin I., and is a same from Form Sweeten and property of the first Hammer and the fer in the mean Rees of Languages of the first terms of the man and the first terms of th there exists the set of the set o

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Rocking to 2 to the continue of the continue to the research t

## III. Orthonilicates, R.SiO.

Salts of Orthorder e Acid, H.S.O., characterizer by an oxygen ratio of for at cor to bases

The following list menudes the more prominent groups among the Orthosuitestes.

A number of basic orthogramics are here in highly which rund water upon no flow also have which are more of essentiation may as a first in a surface of necessary a runding there is the consequent at because of their is a shorter of each entry a national form, as no closely rule of or no there is a surface of the Marie form, as no closely rule of one there is no entry that the there is a hardless that the third with also finds, hardless a non-zero or the entry is beginned inter-with them.

Nephelite Group. Hexagona.
Sodulite Group. Isometric
Helvite Group. Isometric.
Garnet Group. Isometris.
Chrysolite Group. Ortherhombic
Phenacite Group. Tri-rhombohesord

Scapolite Group. Tetragonalpyrandal Liceon Group. Tetragonal. Banburite Group. Orthorhomha. Datalite Group. Monocime. Epidote Group. Manacime.

# Nephelite Group. Hexagonal

116	pretite Group. Encangular	
Neghelite	Typical formula RAISIO, No E AlSiO,	c = 0 8389
Soca-nephelite artif Encryptite	N.A.S.O. Kahophitte	KAISiO,
Cancrimte Mitrosommite	HaNacha NaCOs a A action of (Na, Ka act and Sections)	2c = 0.8448  2c = 0.8367

The species of the Nephelius Guilly are highground in crystalization and have in part the typical orthogocate formula RAIS(1). From this formula nephelic time of deviates son ewist, though an artificial sode-nephelic. NaAIS(1), conforms to 1. The species Cancinate and Microsommite are related in formula 1 also in composition, though in the latter respect somewhat complex. They serve 10 connect this group with the sodalite group following.

## NEPHELITE, Nephelina, Electric

Hexagonal-heminorphic (p. 1.8 Axis c > 0.83893. The structure of nephelic corresponds to normal hexagonal symmetry. It is only in its etch figures that to name uphic symmetry is suggested.

In thick six- of tweeve-sided prising with plane of modified summits.

Also massive compact and in embedoed grains, structure semetimes thin

columnar.

therefore with the destination of the first of the first operation operati

Var I Archelde blancy I send's proved geomy created or grants transpared with vireous laster first forme on life Some a less case is harm creater carticularly of younger of place forks at arcas. 2 Fireface In laste tender creates of more commences maked, with a great later, so I see lish, great at 10 a less in grant in color I seally consided by minute inclusions. Characteristic of grantial crystalathe rocks, symples, eac.

Comp. - NaAlSiOs. This is the coroposition of the artificial mineral Natural nepticate always continue stars in varying eyess unit also small The composition as tally approximates to Nucley Langue

posithete experiments, yielding expense has nephrote with the courses, on Na 1994 . load the continue the at an ard some of the second terms the most acts was for the The presence of portion in a case or who the fact that he wants, so necessarily to the case of the case of the case of the description to the case of the the extension of the New York of the state o enter a start manage of the group are not only those more, set a crypt of LARSON. no I know on the 1 a Section

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to stell agreement of the contraction of an althogen to the green fine of

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Encryptite - LiAciiff, In symmetrically arranges revolute hexagonal cup sented in of ste and terrived from the afternt is of spead standard at amounts about consentacut see

Fug 514, p. 203, G = 2007 Cosoning or white Optimaly . w = 1545.

Estiophilite. Phacelite Phacelite Facelite KANIO, Commonly contains small same total a comorphy is NaAlsi , see under neither to p 585. It becaused your a st bundles of mender are not rotten, also in the threads, or welcome. Pland countages H = 0. G = 243-267 Co. cless. Optionary = @ = 1552, i = 1527 Occurs in ejected masses 42 Mile Source, Ventyrus.

### CANCRIMITE.

Hexagonal Axis c = 0.4224, and mp  $10\overline{10} \wedge 10\overline{11} = 64^{\circ}$ , pp'  $10\overline{11} \wedge$ 0111 = 25° 58' Rarely in prisonatic crystain with a low terminal pyramid A-ray at dy shows a similarity in struct tre between catt-Caunty massive crin to and the sodalite group

Cleavage prismatic in 1010) perfect, a(\$120) less so H = 5 6. G = 242 25 Color white, gray, yell w, green, blue, realish Streak uncolored Luster all vitreous, or a little pearly or greasy. Fransparent to

translument Optically = ω = 1 515-1 524, ε = 1 491 1 502

Comp. Approximately 3H<sub>2</sub>O (Na<sub>2</sub>O) C<sub>3</sub>O (Al<sub>2</sub>O<sub>1</sub> 98<sub>3</sub>O<sub>1</sub> 2CO<sub>1</sub> = S<sub>1</sub> (ca 38 7, carbon danale 6 3, alamins 29 3, lune 4 0, soda 17 8, water 3 9 = 100

The fear every type of formula has been engineered for the members of the expension group the the term of the which the brucks is any be represent to had been or Cutter that I he seem I go to be been to be about the given where I is to see the form F = 2 with

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enture and progration or most character. The or more assect to be negligible way to er are so to tagen empty to do not then the party of the terms of the tomeran every the carbonates, which show much good terferences or

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Street, and an arm with mean or most of the CO's replaced by SO, is found to all aftered pare in Bear it rock, transmitter, Color do. Has hiver refractive discress.

htrefringence than orderinate.

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Darries Near a considerate southers the forming contents Na, M.S. M., K.Alen O., Na, Ch., Car., Ch., Herngeson, Commun. 5 to no. 4 (rately as a 1 518 1 52, a = 15.7 1 527. Found at 20th Souther, Ventovical, Nachtable In

# Sodalite Group. Isometric

The species of the Soil, lite Group are goinetric in crystall ration and perhouse to range [rad also the for owing great Array state above a close steplarity in structure octween the members of he Solidite at I Helvite Groups. In composite a the minerals of the Southte Group are antilar to the minerals of the Canerinite Group and size it are possibler in containing radicals with Cl, SO, and S, which are countries assembly absent in the sitiones. The molecules K<sub>2</sub>Al<sub>2</sub>Si<sub>1</sub>O<sub>3</sub> and CaAl<sub>2</sub>Si<sub>2</sub>O<sub>5</sub> may occur in small amounts, replacing Nu<sub>2</sub>Au<sub>2</sub>Si<sub>3</sub>O<sub>5</sub>.

### SODALITE.

Isometric. Stray of the atomic structure shows a normal symmetry although each figures have suggested tetrahedral symmetry. The Little is a simple cubic one, but near that if the body-centered called type. The init cell contains two replectures. Common form the distocal edge. Twisse two plotters, forming besageout presently elogation in the direction of a combistral axis. Fig. 432, p. 1871. Also massive, in embed of grains, is concentral axis. Fig. 432, p. 1871. Also massive, in embed of grains, is concentral axis.

Canvage dedicasascini, in re or assedis met. I racture corchodal to uneven. Britile H = 5.5.6. G. 2.14.2.30. Lawer vitres as, sometimes in heing to greasy. Coor gray greenst velowish, white sometimes the height red. Transparent to translateout. Screen on cored.

n = 1.4827

Comp. 3NaAlS( $O_s$  Nat 1 = 8 Len 37.2, alan na 31.6, soda 25.6, obtarine 7.4 = 10.7, deduct (O = 20 - 1.7 = 100). Potassum replices a small part of the social

Pyr, etc. In the chosed take the base varieties become white and opaque. Bit from a the standard content of the content gives be able to the horse and of yields greater a successful evaluation.

Diff is against the rule is de such and have tells cher a consume demonstrate the moment of the process of the later terms and

forest

Macro — Recognised in thin continue by no very like references and rope character and such if good even age lasts, is and now by the lasts could be now versel for a rectional type a green and thin group may be the ingredient from one body to extrain giften by his like particular which in a lower to extra more than the restaunch one in the particular of their which is the crossing a first with the particular of the substitute of the crossing and state which is the crossing of the substitute of

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the edular as extends artificial inner a fife the new own laws "the

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Outagie. Also in fine large master will blue color on lee liver a tributary of the Reaverfoot, near Kicking Horse have bestud to a box

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Are KITE A so she of successful and a with a most successful of other se approxithey or been sould be. Our re an available must provide a state or place stee of character, New Zonadu:

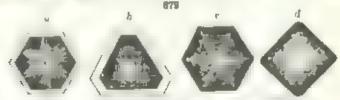
### RAUYNITE. Hanvas.

Isometric Sometimes in dodecahedrons, octobedrons etc.

Twins rw pl o 111) contact-twitts are pulysy ob-tic percentiontwins Fig. 431 p. 187. Commonly in rain fea grous, often looking like

crystals with fused surfaces.

Cleavage godecateded rather distinct francisco that concurred to uneven Brack H = 5 % 6 G = 21 25 laser vitrous to somewhat greeny (come bright bare, say-bare, greenish thue, aspar of negreen,



Sections of ervetage of hasystate cafter Monly

red, yellow. Streak sightly blund to colorless. Subtrainparent to transactcent often encount symmetrically arranged melisicus Fig 879 a = 2 4061

Comp. - 3NaAlSiO, CaSO, Sirva 32-0 sulphur trionide 14-2, alui ana 27 2 mm 10:0 soda 10.6 - 100 The molecules BASiO, and CaAs, Sure i

may also be present in small am inte-

Pyra etc. In the chief to be estama ste color. If It is the foreeps I nee at 4.5 to a white glace well his in he was expressed and was a great our was proportion The solvering menter or the some new teles with him a chlomar

Micro. - Similar to sudalite, which see

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of a suplicate national idea from to

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## LAZURITE, LANGE LARGE. LARGING.

Isotastric In cubes and dodeenbedrers Commonly massive compact Cleavage dodecahedral, imperfect Fracture aneven H = 5-5.5. G = 2.38 2.45 Lauster vitreous Color neh Berlin-blue or asure-blue.

Violet-blue greenish bain. Transcipent a = 1500.

Essentiant 3NaASO, N.S. but containing also in isomorphous employed the many thate and solution to devides. The character of the subject to lead is uncertain since in artificial intramarine it may be Na.S. Nach, or Nath.

The hoteroges were character of what had long present as a morse concern in ter the name lapse at what is not it will be their 2 runt to any to read it longer on the contracting to the contracting to the contracting of the contracting to the contracting of the the ter distinct of biologies to a ferrice in a stitute ter fire a trac, and I refer a a we the first entire name and the first to the terminal in the traffs at the to decays to passed one orthodose a conquert to apart to has to extend as an an an armost a set of order quality and apart solve its most a set of order quality and a second Regardes by Brogger as a result On the first method of the section o

Micro. To all o melas e with the

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their want a tracking round to more or lesson or of growth from

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Further b. Che nother to be of the set, who there highly extremed for cost a cost of the set of the dem coup of the talk att the risk to more information. This has been replaced,

bowerer, by artist to a future, to a not a portant the mercal prospet.

# Helvite Group. Isometrue-tetrahedral.

Helvite. 3 Mn.Le BeSiO, MnSt Danalite 3 Fr. Zr. Ma Bositi, ZnS Eulytite Busilia Zunyste (Al, OH, F, Ch. A., SiO.).

The Heaven Guove and idea several care species isometric-tetrahogical In crestallies on and in composition and struct its related to the species of the SUDALITE GROUP

#### HELVITE.

Impetric-tetrahedral Commonly in tetrahedral crystals, also a sphere cal masses. The about to structure is similar to that of sociality. The unit

cell contains two molecules.

Classage octatedes a traces. Fracture aneven to concluded. Britile H = 0.65 G = 3 lb 3 36 Laster vitreous, norming to resinous Color hopes verow, near by to yel with brown, and seein green reddish brown Streak in colored is among around n = 1.739 Pyromeetric

Comp. 3 Ma, Fer Bess O, MaS

Pyr vic Fuses at 3 RF with intermercence to a vellowith house, upa in head, beers og tarker in H. F. W. hithe Given go er he congresses reaction. Sain 3 . (v.lpc-Obs. Hearte we be a verne with quarts, horstsends, and true are and a pognishia

veins, also found at times in guesa.

Found in the Imam Mita. Russia, near Moule in large opherical masses in promisite. In Ramonica a Kanadabarani in Saxony at Bressenbrana as a new near set warrest erg in guess. In horselve from the algo-escaptes at various some or the languaged and is-Vargir a. Names to Ween of its all assen to me voters calor, from game, the men

Danasite 1 s. Zh M. Boshi, Zha. In octabations usun i tussive H = 5.5 ft.

G = 5.427 Coast reshered a gray n = 1 TM. Cocars in bases to Massachusecta,
in stud grides assessment in the Promport grante I ape this with agreetate and practice. at the tinet one at Bartiers Carrier is New Las prince Propertied from West Chevento

Castion Pl Page to Commen. I were also at Ree're to their any

Emptite B , Sat , I some vanistic tetrahears crystals also in apherical farms. Nergy stray appears of many or a time of cell H = 4 1, a 6.1 (for north a rebrown to grow the stray vol w, or concress, n = 245 Fented to belong with many of
humath near 5th echerg, also at J-hampsongenerally, o crystale operate.
Zangite A post least at the control of absumant, approximately, MOLECT pa
Also on. In time of the statement tetrahadrons, H = 7 (for 287) is = 100. The approximately of the control of the contro

Silverton, Sup Jean Co., and on Red Moustain, Sans Co., Coloroso

Agricolita. - Same as for onlyttle, Br. SiO, a but mone one. Fiberess. In globular of semi-globular forms. n = 20. In Saxony at Johannesorgenstant and Schnerberg

## 4. Carnet Group. Isometric

R.R. SIO, or 3RO R.O. 38104  $\ddot{R} = Ca_i Mg_i \dot{F}e_i \dot{M}n$ .  $\ddot{R} = Al_i \dot{F}e_i Cr_i \dot{T}i$ 

## Garnet

E ANDRADITT CasFor(SiO.), A GROSSTLABITE CasAldSiO.) Also of a Vig by Stoy MgAle SPAR B Private to dres St. Lee lab ALMANDITE Fright M.O. 1 F UVARDVITE Cast of StO.), Mar Alasath D SPESSAGITTE

#### Ca. Fe Tile((ScT: O.). Schorlomite

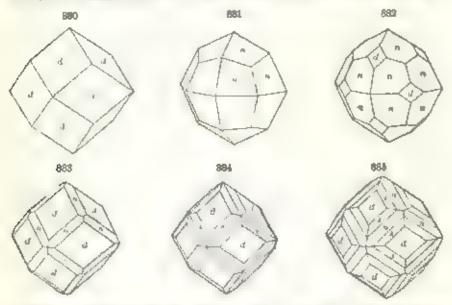
The CARNET GROUP includes a series of unportant stit-species well ded under the same specific name. They all crystall ze in the normal class of the permetric system and are aske or hal t, he dedecahedron and trapegobedron being the common forms. They have also the same general form da, and while the ever and present differ writely there are much intermediate corrected. Some of the garnets include to an improving 8 to 1, and the g they are connected with the rare species schorl unite which pre haby also has the same general form the

#### GARNET.

The dedecahedron and trapeze edron a 2111 the common sample from side these in combination, or with the heaves desiran side. Cubic and pershedral faces rare. Often an irregular embedded gradis. Also massive, granuar, coarse or fine on a somet mess fresole, amenar, lamiliar there and bent. Sometimes compact eryptograsticate like apparte. A-ray study of the atomic structure shows a complicated un a cell contain ug eight molecules. The Sith, groups are nilependent of each other, the R stome lie.

in the center of a group of six oxygen atoms and the R atoms in the center of a group of eight oxygen atoms.

Parting d(110) sopretimes rather distinct. Fracture subconchordal to move the trie servicines in all twhen granular massive, very tough when compassive at the trie H=6.5 7.5. G=3.15-4.3, varying with the compassive at 1 ster various to respect, Color red, brown, yellow, white, apply green, black, g is rest and green, g are siten bright. Streak white transparent to so translacent. Of g, exhibits anomalous double refraction,



espects a grossificate of discrepandate, etc., see Art. 441. Refractive index rather high, and a very night of a visit the composition. The different pure the localist have operandately the following matters.

Propped 705 Locasidarite I , & Spressritte Stat, Amazonto I 830, I variouse 1 870, Amazonto 1 845

Comp — An orthogheste laving the general formula Roll Sudah, or 37(0 kg), 38 th. It is a choice that the property can be called to the magnessian, formula from a many uses. It is a choice a sharp num, form from or chrom in morely the ann. Cather, sharp sage somethy represed by the rum of there are appeared to be used to their mentions. In the case, he wever, where there are present our simple to their mentions in the case, he wever, where there are present our simple and moderable in the case, he wever, where there are present our simple and moderable in the case, he wever, where there are present our simple and moderable in the case, he wever, where there are present our simple and it has been pointed on that he grame simple doctors, in a substitute of two pointed out that he grame simple doctors, in the proceeding the constitution of the thore are there are those the later beautiful access, in the proceeding the three allows of the home and specific gravely vary kreetly with the variety on a contract of the home and specific gravely vary kreetly with the variety on a contract of the home and specific gravely vary kreetly with the variety on a contract of the home and specific gravely vary kreetly with the variety on a contract of the home and specific gravely vary kreetly with the variety on a contract of the home.

Var There are three round out groups, and various subdivisions under each, many of these heading into each other

L. Alummum Garnet, including

A GROSSILATUTE Calipun-Aluminum Guroet Ca.Al-/S O.h.

3 Proper M grossim-Aluminum Guroet Mg Al. Sol. i
C ALMASDITE Jun-A in our fairnet Fe, h. Sol. i
D Spessautite Manganese-Mammum Cornet Ma, Al. Sol. i

II. Iron Garnet, sucluding

As reduce Carrier Carrier Carrier Carrierous
 Ordinary (2 Magnesian of I tanderous A) Veriferous

III. Chromium Garnel.

P [Ivanovitk Cale,um-Chromann Garnet Ca,Cr, Sp),),

The name former is from the Latin general, majoring has a given and hierary from principle to me, the paper of which are usually in neurons, and two, it is sentent to the assert of the city of the paper.

A Grossmante Essonie of Resente Canti pensione Calcamationiam Great Fermus 3 (10 A 20.38 n); = 50 cm to 0, norma 22.7, have 37.3 = 100 - three certaining ferrous iron replacing the carriers and ferror from replacing a mannan and hence graduating toward groups (and E. G. = 3.53 (blue a colorless to white to purge groups), amoreand honey-vedox of wine-velocity brawnish yellow, or non-brown, to none per carrier formeral types from the presence of chromatant office, shows optical protein as (Art. 441).

The continual generalization of materials that they destribe pure press from Schools, and was to take the bottom of the continues of the considered to a situation of the continues of the contin

I are green, we have the and we now known garnets are not appeared a greenplante stone on him group of a areas area cannot, or

Ancross to:

B Printer Premius garnet in part Magnesquim-administin Garnet Formula (Mgt) A 44 35-64 = Suca 44 8, alumnia 25 4 in agnesia 29 8 = 100. Magnesia predominates, but carried and run are also present, the original prince disc contained exponential G = 3.51. Unior deep red to nearly but a Often periodity transportational theoretical as a gent. The name pyrope is from superior, breaks.

Readable, of deleter shape of pair the roll as I jurgle brillian by reflected light, comes at the components at the partial dipyrape and one of a standard, from Macon Co., North arother

C Almander Almandine Propose garact in part Common particles that I from aliminam Great Formula (field Alg.) 38(t), = Siden 36.2, a mains 20.5, from protoxice 46.4 × 100. There from replaces the electronic to a greater or less extent. Magnesian also tep ares for ferrous from an I thus it gendences toward pyrope, of the solds along to Color line deep red, transparent, in previous garact, brownships of transparent or subtransferent, in common garact, back. Part of common garact belongs to Institute.

The Alabamir carberacles of Phay were no collect because out and polaries at Alabamia. Honce the name alreading or almandile, now in use.

D Spessariting Spessaritine Manganese-alumanum Garnet Formula  $3 \, \mathrm{MnO} \, \mathrm{AlcO}$ ,  $3 \, \mathrm{Su}(\zeta) = 5 \, \mathrm{mas}$  and 4, alumanum  $2 \, \mathrm{erg}$ , manganese producted  $13 \, \mathrm{J} = 100$ . Formula from reposses the manganese to a greater or less extent, and forme from also the  $\gamma$  due that G = 4.15. Coor dark by a cuch-red, so metames with a stage of value, to brownish red.

Particle a congress a secrebed as no as the name constraint of a presentate but transduction of static of the trees not a change of non-secretive and section of the theory of copy where of Orate Pour mean become bases. Visualization is better species. Propcylyndia, Ramanus.

E Anomaire Correct Games. When Games are Calcumstant Cornel. Formula (a) Feeth asto, = S and 35 5 from sesquences of 5, and 35 1 = 100. A anomain replaces the former run formula not, manganese and sometimes to agreement replaces the cultum. G = 3.75. Colors various with topuzzing greened vellew, apple-green to energic green browned rod, brownish yellow, grayssi green dark green, brown gray so black, back

Named Indicates of or the Pottog ere is notability, a ladicate who is 1800 described and it and one of the state of samples, also broken there are the following wars as

I shall Contain seen Cornel to see the the productive are with an almost whoils time their set of the set were the terrand of the second of th

I have a consistent of the construction of the

Hall to a constraint the process of a constraint of the process of a constraint to the process of a constraint to the constraint of the co

F Characters Observate Coverous Calcium-chemium Garnel Formula (Cata Crob, 850) = Silver (Ca), capitalia sesquexide 30.6, and 23 = 100. A uniquen takes the part of the chemium in an part. H = 7.1 Cross 341 a 52. Clarent characteristics

Other varietal nature for a been proposed. Straight from thes Song Section I, and to tag Ste per strain grant to as the Suptain or garrens or to give another as management of a superior at a page to the grant or to be

Part size. Med orieties of garrent estimated to get a new at one great he as to mount to stresswift on process and the country and of and recipe the man one oftential former garrent of mounts of lighter hands are until the most after all the recipe for one garrent recipies and the second recipies and the

The density of garnets is largely distinushed by fusion. Thus a Greenland garnet fell

from a 90 to and on hours, and a line gree lar-to free 3-02 to 2-5

Diff — Characterized by isometric restallimits, much to us ated crystals, dedecated ross or trapsistioning massers forms rure, then somethy generally the distributions of trapsistioning massers forms there is much knowledged and the desire than the contraction of the specific grants of larger than to be surely the specific grants of larger than to be surely that the forms of the form which is lifters in form the much har for than spharetic.

Micro. - Insting that in this we has to its very as in it see of sea of clearing isotropic character, isomity shows a page park color, sometimes not reachly told from some of

the sylnele.

Artif While members of the garnet group have been furned artificially their scattlenia is differed. Apparent vities can be consisted only in set exact one of temperature and resource that are difficult to reproduce. Natural garnets when fused break down

into various other marrials.

Obs. Carnet a carenon are, widely distributed. It is usually an accessor, men making concern, soing found it is great our oft of rock types, more partitudings in teach formst ende, and of the worsts up, to green to creatalline horsetones and to contact, topics ples in grant cover, con l'occurrant un varions vidensie conte sometimes in surprir and It ears at course to be made the masses of the separation of the state of a rock. The arrivaar made of accurrence is largery agreement in the chemical or apportunit if the gardet at queet. Gross act to a regar ally charac criefly of me among team an pare rate areat, where, who her nature for home grow as or general quetamentplan processes or is to be even until y 1. In the encount sort of our bengancies rocks not on the error advice of the Artists this te characteristic of the mich as tiple and metalinophy rocks remaining to .... a and even is we really in some given a cost, as the really dister with an an are more imorphic, recesses, it force with the vacuum or may have a and amounted to the rick as agree I are a morning there entre territe as the rate ignorest rocks as are formed from ingrans containing to the suggestion of our with histories positioners as the parties from it for the activities of the suggestion of the sugges the sergen rate formed from those rocks. Then often associated with sportel, elling to ste-Spengride congre in granuite rocks, in producte in whe stone set as a Reignar of his bases hoped with topics in his bases in there is Convenied. The times we say if no lead in, molarite, is common in scuptive rocks, ex so say wat repheness. I learned that in phonelites, leavilophyres, not believes at a rat cases often then forms or news when with a tidas ferrore gerried sometimere in sonal intergressib. Id more over us as a predict of contact meta of logy. Demanted occurs in sententiale. I discut belongs particularly with chemistry a semperature of open the main to give a state another

Carnet expetable dies contains to themes of foreign marker test only in part due to at oration me was triangle related, epinole quarta but 5.2 p. 302 or times he garried as a riere size or personarch, in the mail of a coloring of an electrope see. A bank partiel limit Arct. of Norway contains the contains and operate, creatain from Twodestrand Nor-

was, are what a cause with a there being not a the crust of germed. Or where from how Westerwick Maine are dodes shedman with, a that which of e in runn-stone menting on the others from the runnel. Maine who is more than error of germet and malerte. Many such cases have toom those.

translate are often altered than to enjoyte, serpenting, even to be so its. I rykinds of pure person action new surface and by a chief to come any purity of behaved not

house grown in all the and the said

Only the new plantage less than for the resource of garrier as the tentional error of are have been given to the precision place as a restaurable of our or the Cherographic and the restaurable to the affects types. It is to be a more, he was error tout if it has a more types of the following to the affects types.



the state of a pure green shooter rance from the banks of the Vern force in Vake tak, Siberia from tele most of near k see at a the Ziat ast barret total Max. Receive to Remain an expression of the convents to from Craverza and the near by lost a set of relative and from Vingan Vin

Morelus, called various v landente, automoste, and recolds, also from James, Lower

grand one para limberous of the section which is semential which has been derived from

a per a state of the compact to the where the carriery used as a gent has been characted on the compact of the to be seen to be a state of the second transfer of the feet of the best of the Cooling on the long tent trees, and one Very large expension are too. It is a children with a contract of the contract of the

Many 1 at 11 to dear not the A of the Montesta in temperature

eres with an attack in the first and attack a American become

A neg to core a core the core, press connected to done external a got was a school by a top or Mit and a new or seems er the er real time is not buy one observation to the objection to for many the bound for many the agreement groups with the tracks which is a set to the black organization of and enterty care and to the black organization forcing are found on Mits. She is a long with a set of the set there I we to be high the hinder second of the or or I was a few of my can use to large that here were to be design adventue trans at Are to the Aust Agdor, Norman, from Pitteranta in the among a large of the State of the Australia of the State of the Aggree of the Aggree

Rines to the terms of the first and the second Corp. and the second se Manufer models, at the second of the second Manuel matths at the second of The strate for the strategy of when had not a thing a get will a look a spit of a M of the care designed from the burney or proceedings. The new control of the state of the first time to the first time to the new control of the state of the new control of the new I was the state of the state of the state of discussion construction to a new construction the many behalf at Wannight a the garage of \$ 147 car of are \$ .

I the secretic beginning remarks that and short-rooke to make his minute Vir y arge means are any work parents have the pale of respects, or to a at many and there have the way or a school triplet given currently the no to

Asse man de mont

Use. He was a see and transferre garbels are not as scuspencious gen-

athetes. A to by the first is not be and as all for ye.

Schortomate Part & garnet (at he T a 2 3 Tor), Perhaps to the control of the control of and and the control of the contro 14 to 20. It stand theses with rephetite and brook to from Magnet Cove, open Hou Springs, Garland Co., Arkansas. In masses of considerable size in a nephelite-specific from the lee River, a tributary of the Resvertoot near Exeking Horse Pass, British Coumbia.

	Chrysolite Group.	$R_2S_4O_4$	Orthorba	arlac	
		271 173 112	hh'		
	13	0 A 110	OLI A OTI	a b c	
Monticellite	CaMgSiO <sub>4</sub>	46° 54	60° 52	0.4337 1 0.5758	
Glaucochroite	CaMnSiO <sub>4</sub>	47 367	60° 18	0.441 1 0.591	
Forstente	Mig8iO4	49" 51"	60° 43°	0.4648 1 0.5857	
Chrysolite	(Mg, Feli-SiO <sub>4</sub>	49" 57"	60° 47	0.4656 , 1 , 0.5805	
If setemolite	(Fr, Mg, Mn, ShO,				
Fayelite	PeasiO <sub>1</sub>	40° 15′	60° 10'	0.4584 , 1 : 0.5703	
Knebelite	(Fe,Mn) <sub>3</sub> SiO <sub>4</sub>				
Tephroite	MagSiO.	49° 24′	01" 25'	0 4600 1 0 5939	
Larsemte	PbZnSrO <sub>4</sub>			0.4439 1 0.5324	

The Chrysolater Group includes a series of orthoul cates of magnesium, calcum, iron and manganess. They all regardline in the orthorisembar system with but lettle variation in small ratio. The prismatic angle is about 50°, and that of the min bracky done about 60° corresponding to the letter if reefold twins are a served. The type operas is carysolite (or always), which to make that magnesium and iron in varying proportions and is noncontermed; to between the comparatively rise in greenium and iron shoules. X ray study of the storms structure shows that the Sath, groups are in spenden of each, other that the magnesium atoms discovers are guitar groups of sex exigen atoms and are of two kinds. In mantischile case set of imagnesium atoms is replaced by calcium atoms. The exigen atoms he nearly in the positions required in a largeonal flose-packed structure.

In form, the species of the Corosolite Corosp. RSO,, are closely related in node to chrosolicity, Bot (A), and successful was a select. The species of the Disspect Croup. If, \$42, etc.

There is not in districting receiving estimate the chrysolitin and the building see p. 1230.

## CHRISOLUTE, Olivani, Peridut.

Orthorhombie Axes a b c = 0.46576 1 0.5865

POST TO SERVICE STATE OF THE PARTY NAMED IN COLUMN TWO IN	110 A	110 -	49"	57
Ad'.	120 A	I20 =	0-6	- 4"
uld'	101 A	Tot =	100	6"
Ath',	OULA	0% -	USE	ĕ
MAL.	111.4	111 -	40"	70
g	12L A	121 -	73"	13'

Twins rare 1w pl h(011) with angle between basal planes of the two mulviduas =  $60^{\circ}$  47', penetration-twins, sometimes repeated 1w, pl w 012 the vertical axes crossing at an angle

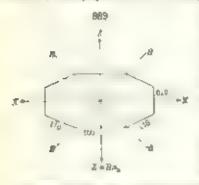




of about 30° Crystals often flattened # a 100 or b(010) less commonly stongated c axis Massive, compact, or granular in embedded grains.

Cleavage: b(0)(0) rather distinct, a(100) less so Fracture conclosial. Brittle H = 6.5.7 G = 3.27.3.37, increasing with the amount of trop, 3.57 for hydrosiderite (30 per cent FeO). Lister vitreous, Color green —

commonly olive-green, sometimes brownish, grayish red, grayish green, becoming vellowish brown or rou by exhibition of the iron. Strenk usually uncontrol, rarely vellowish. Transparent to transparent. Option by + Ax



pi : 001),  $Z \perp a(100)$ . Dispersion  $\rho < v$ , which Axial argic large 2\tau in reason with tise in percentage of FeO, at an it is percent FeO the axia argle to comes 60°, and with a further increase in het content the sign beauties. Indicas with the sign beauties. Indicas with the sign beauties at 100°, contents with change in percentages. If 100°, contents of  $v = 1.635 \pm 0.56$ ,  $\rho = 1.65 \pm 67$ ,  $\tau = 1.67 - 1.69$ 

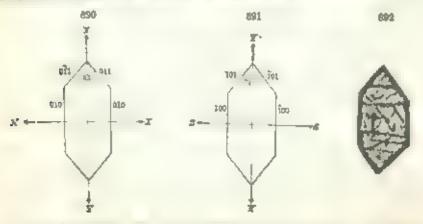
Var receives Of a pale yellowish green rose to a charge green of a 3 141 to 51 feets a to week to become an large of a horizon egg to a consideration of the green to be be a feet to all the green to be becaute the leaves to be becaute to all the green to be becaute to be a second to

Common Or one - Dark collowish give to have or softengered to a 120-340. There also be a raile of greater the one eguation remains the best to be leavened to be legal to our eguation of remains and the land to be legal to our eguations of remains.

Comp. (Mg | 12 8,0), or 2 Mg | 10,0 Set. The ratio of Mg. Be varies with a from 15 | 1 | 12 \* 1, etc. to 2 | 1 | 5 value dente, and hence passing frem ferstrate on the one sate to favilite on the "There. No sharp bee can be stown as enforced to T branch box to a separation present replacing a man and makes in the transfer quantities.

Pyr. etc. 114 w true, but us of public as continuous begand best end follow verses on rich is not seen to a large in R. she as his for an end best p. W. But for a pive requirement of the second continuous rich and the

Daff there is so the afmentity, the yellow green cour, gran the farm and cleave



Milers Recognized in this sections by a high relief, lack of color, its few but marked rough eleavage-colors in ght interference-colors, which are usually the oritinal air, proposed known of the second oracs parallel extinction, biased character, characteristic

out men femally with soute ferminations when in distinct excetals. Figs 889-801 to free good resonanting with copy or as a made of the revenue on most of the wigner of is now topics, to serpen me the first stiges in ig a like by the separa sun of primate grams along the mer of the are by S.

Arms . The influence can been of the Christian to Caroup have been much synthesized

to the later than the same of the same of

Obs broke to the har as for the man discourage to be given as rocker de persona e a se francia, e a uni a significación de disconerente e e esta en especial e en especial e en especial en esta en the service of the service of the service of the service process of the service o and come a distribution of the section that I have been The first the second se Pop to the hypothesis and a realist that the second to the

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Carriers at Welmier, Jectore Co., car. Magazi C., and on over

greats great was a particular on an expensive of the factor of the properties of the this (x . the contil so a for a for a for the form to the this the program of problems, on the course for a to the second problems the course have been as the course of the cour

Chapter Is

Use The cieux, fine preen varieties to next as a gern state to the a ended records.

The artist rame of the other marghests of the character of thoughts given at the table on

p. 58). The species are the properties and the lighter

Monticell e i Marco I e d'en redensermans II - 1 G + 32 Courses outes Op o red fat many sets of e mal 21 - 21 is in the part of the part o It at my reporter that a har event Man . I have taken It I noticed a cont Prince to Recover Co. of the Same of Same Late Holard Late his a tes were shown to be as as well on will te

Glancochroste — cubbasio. In propose arrows and groups H=0 (c. ). If H=0 is the at 0.5 Car, delegated non-grown. G and G is G in G. Moreover, G is a G in G in G. Moreover, G is a G in G in G. Moreover, G is a G in G in G.

New Junes

Pornterite. Mg-960. Orthorhordus Is small our demonstrand or tabular crystala. Cleavinger man led 1 101 an 01 H = 0.7 to m 3 5 2 3 C of worse, given list of virus. Options y positive 25 targe Az p - 000 Z + 100 a 4 to 5 of = 1 + 51 y = 1 + 70 (secure of the colors of colors of ejections of a contract to secure the terms of the colors of the color May as at if Rouse, with surperstant of Superstant Physics I. Norway; north of May at, Ural Mia, and in directions on the Conservable Banco. Bostonic is listeminated through a mestone at Rollon Worcester Co., Massachusetta, o masses which are often over an inch

through and rectangular in seconds.

Horomoide - be My Mr sails. In rough dark-conord crownly or masses. G -30) Openthy In the rest sill Or us I the ron , me of Marrie Orange Co, New York Iron More Hill Conderson ! Bless boand Asso report on from the

true and mad Robe on

G. = 11. Optically -. Color has given only ye when to me to such in expanse. As 5 , 000 Y , 000 A SO a = 1855 B - 1877 5 - 1886 Fronte a to got to obtail an or the Lamer Barrie. Since, from the aster I of Panter one he appeared in commerced to In m. Az era la bear e fro. On excess bor. For mother to sense Ma 4 June freign Mangitulague to occurs at 11 octor new remainland banden In he United States in on I are not near somester, began to Massoch set a Harbyshie at the one ( of to Vellematote Park, Wyomeng, Found at Chevenne ( any m, Pike a Peak regard, El Paso Ca. C dogado.

Knebeste. . Mr par , Purely in crystals with habit special to those of chrysidite. H = C5. G = 4 . Postere at 1. If you characters choose amount to those of favalite.

Found in the montemangament of appears of Sanden

Tephronic - Mr. 5-1, 1180 with rine in the variety corporate. Rarely in an all crys-

the ake those of the scale  $|11\rangle=0$  (a. = 4.1) (b) a tech sed to aslog ray decay  $|4x\rangle$  pr  $|00\rangle=1$  = b axis.  $|\sigma|=1.77$  3 = 1.807 = 1.825  $|21\rangle=607$  1 and at Sterling full and Franklin I trance Sussex 6. Now Jersey A so a Vern hand, owners, at Poppers near Persons and at Lingtonian tear. In France at Aderes of the ex-I verodes. Pur dephente from Langhamsbyttan is a variety intermediate between forster the and temprorte

Largenste 14 7 - 8(6). Orthorhousing to sleep but admitted primme occupangually talular [ (010). Prismatic cleavage good () = 5:00 Wh. e and invesporer: Agamenttime hinter Chairm v Ax 1 001 X = 3 axis at 12, "= 1.05 ; = 1.05; = 1. loss assertant) with our hearte horiginationate, waternote, rochingson, sardystoane, berient te noothe te cambi a auser de etc.

Calcum-barsenie 19 t. 7 7000 t. Ph. Ca = about i † Massive Indistinct cleavings 1,  $\gamma$  1 121. Where, opeque 19 t. ally 21  $\gamma$  5 a = 1 700  $\beta$  =  $\gamma$  = 1 700. Another war pie 21  $\gamma$  10  $\gamma$  = 1 700  $\beta$  = 1 700  $\gamma$  = 770. Found to the same occur-

tence as amende at Franklin, Stases to New Jersey

Alleghanyile. - MnO 28/O. Orth rhomise Lemellar twinning shown in thin metoo in fregular grame  $11 \times 5.5$  (, = 4.0 Color makes graph pank a disably q = 1.750,  $\beta = 1.780$  ,  $\sim 1.79^\circ$   $2V = 72^\circ$   $\rho > \nu$  frame  $\alpha = \text{von with clust}$ numerar we in needle appearante, rhadon to mangamferous calcute, tephrode, galakite etc.

Consequently A managed of an inheate semperation distribute. Orthorhemore Pries the demander of the last that the plantage of the last strong are regarded to the Prochame I = contract the green Z - a contract or a contract to the green Z - a contract or a contract of the plantage of the contract of the green Z - a contract or a contract of the green Z - a contract or a contract of the green Z - a contract or a contract of the green Z - a contract or a contract of the green Z - a contract or a contract of the green Z - a contract or a contract of the green Z - a contract or a contract of the green Z - a contract or a contract of the green Z - a contract or a contract of the green Z - a contract or a contract From harmak to be us on her a to they the and of ourse of the east on the astern theighton

Larmen (asset a Manual to the grain) and in parties for e and take at r > 1. This Shows polysynthe a therefore 100 Company 100 Company 100 performent are grain optimility + 25 moder doty large q = 1.707, q = 1.716, p = 1.716 bases trace formal by heating of shork to no her a between professy derived with the article in a 2 25 it). On the min to make a country true of Serve III, near Large, Co. A. Ir.m. Ireland, amoralted with aparence one in partwent e and aparen

Merwante (a. Mario), Manchor In grants, showing two are of polyscothene twinning (inarrage for H=0 C - 3150 topolese to pass green Vitrous laster Optionly +  $\alpha$  = 1704,  $\beta$  = 1731 > = 1735, 2V=6r Dispersion  $\rho$  > r, Z=000 A  $\Delta$  axis = 3s. The area of committy concention with generate againste and most series as the contact metan right rear at 6 reachest, near R versule, Castorna. Also noted with space to any larget at Scawt H d, Co. Anima, irrand and the Velardens, Durango, Morson

Trimerite Ma (a god), Books, Monocour Pseudo-heavyourd owing to twin tring In thick to a lar prise of rusts a library closure H. = 6-7 G = 3474 (Glor salmon pack to be sely a lor was once all ere stalk, topingly lindings, 17-5-17-5. In Vermland, Sweden, at the Hurstog own of a system mear Persters and at Langtonials Han-

# Phenacite Group. R.SiO., Tri-rhombohedral

Willemite	Zn <sub>2</sub> S <sub>1</sub> O <sub>3</sub>	642 301	0-6775	
I roostite Phenacite	(Zu Mn);SiO, BegSiO,	63° 24′	0.9611	

The Phesactty Guoty includes the above orthosilicates of one (mangapese) and berydom. Both belong to the therhomodedril class of the trigonal detact of the hexagonal system, and have nearly the same rhombodedral angle. A-ray study of phenacite and willemite shows a more completed atomic structure than with the noncrais of the chryst degroup. There are six molecules in the unit thombodedral cell. The school and beryllium or zure. John are each surrounced by a tetrahedral group of oxygen atoms. Each oxygen atoms which he nearly at the points of an equilateral triangle. The rare species trimerita, Vingan, Berston, which is pseudo-hexagonal (monocinic) is perhaps to be regarded as connecting this group with the preceding Chrysonic Group.

Disphase is probably related to the Phenaeste Group with a similar structure. It also shows close crystamographic relations to the members of the

Friedelite Group.

			No.	r
Dioptase	H <sub>2</sub> CuSiO <sub>4</sub>	Tri-rhombohedral	54° 5′	0.5324

# Friedelite Group

Friedelite	6Ma0 2Mn OB,Ch, 68 O 3H O	
	Bar contactions of	0.5824
Pyrosmalite	6 Fe, Mn #0 2(Fe, Mn OH Cl = 68; Oz 31149	
,	Rhombohedral 53° 49'	0.5308
Schallerite	6MnO MadcOH (cAsOn) 6805 3HiO?	
Molybdophyllite	4, Mg, Ph)O 4(Mg, Ph) OIL 48(O) B <sub>3</sub> O	
	Recombideded	0.540

Various types of formulas have been assumed to the manerals of the Eriedelite Group but the exact relations still seem uncertain. They show cryst diagraph a and structural surnament. From the results of X-ray stilly on pyrosulahi it has been calcided that the formula should be written 3(Mn be 10H Cl. Mn be Sith. This, however, can'd be written an ultration the formula given above and would lifter only at having 4HgO instead of 3HgO. For such independent of the structural unit cell. It has been suggested that the species bementate, directure a regovernite, hemitable, parsettenate and errite may also be related in this group.

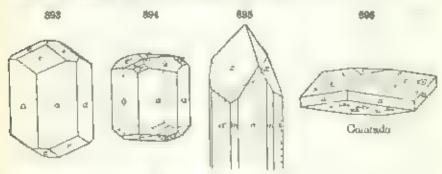
#### WILLEMITE.

Tri-rhombehodral Axis c = 0.6775,  $m' = 10\overline{1}1$ ) h = 101 = 04° 30',  $ee' = (01\overline{1}2) h = (1012) = 36° 47'$ 

In becagonal prisms, sometimes long and storder again short and stord; turely showing subcreamate free distributed according to the phenacite type. Also massive and in lesson ented grains, fibrous.

Cleavage (10001) easy, Moreanet, difficult, New Jersey, a 1120; easy,

New Jerse. Practure conchoids to uneven Brittle. H = 5.5 G = 3.90-4.18 Laster vitree-resinous, rather weak Color white or greenish yellow when purest uptie-green, flesh-red gravial white, yell wish brown often tark brown when impure intreak incolored Transparent to opaque. Some varieties fluoresce strongly in illus-violet rays, in green, yellow, etc. Ar final wallemite fluoresces only when small amounts of manganese are present. Optically + Refractive tablets year with the content of manganese, for pure one silicate,  $\omega = 1.891$ ,  $\epsilon = 1.719$ 



Figs. 803-895 New Jersey 6/0 112 u 2 173 m 3 1217

Comp.—Zano orthoscherte, Zr.S.O., or 2ZnO.SiO. = Silven 27.0, zinc oxal. 73.0 = 100. Mangat esc often replaces a considerable part of the mat (in troostite), and in it is now present a small amount.

Pyr, etc. BB to the errope glows at a loss with ifficulty is a white grantel the varieties may be a losser flag to a 1.4 fb a sequend amount or charge at mile is a 1.5 for any matter that is a constant of the matter of the mat

Obs. - We many so ats a some encounted each arrows of the zon immeries, for most there is given if some or in the most of the second of the se

Use. - An ore of sine.

#### PHENACITE

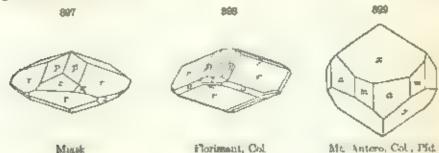
Tri-rhombobedral Axis c = 0.6611,  $m'(10\overline{1}) \wedge (\overline{1}101) = 63^{\circ} 24'$ 

Crest de commonly rhombolicard in habit often lenticular in form, the prisms warting also prismatte, somet thes terminated by the rhomomedron of the third series it see faction pp. 127-129)

Convage c(1)20; distinc r(1011) imperfect Fracture conchaided Brittle, H = 7.5-8. G = 2.97 3.00. Luster vitreous, Courless, also bright wine-yellow, pule rose-red, brown. Transparent to subtranslucent Optionally +  $\omega = 1.6540$ ,  $\epsilon = 1.6697$ 

Comp. - Berydrum orthosilicate, BesSiO, or 2BeO SiO, = Silica 54 45,

glucina 45.55 = 100.



Pyra etc. Arme remains utilitered, with borax from with extreme showness, token p diversed, to a tropsparent glass. With sods off his a white enough, with more, util-

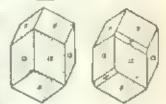
mences and becomes of so the call has no haround sometime.

Obs. Met common from a pegto, nee as a one contribe. On east, assentated with a serice pice, timese, and quarter who, is grain to drusses with additional Charles in primarity or state in times solute at the or evaluate it has solven above the Tax was a fiver, east of the decimining, in the Unit Will Primary, where the orange is a second of the contract of t neutrick trackes access, as trops weighed more than I too no. Also as a said than substitute on such and Mank in the History Man. In Switzerhald a Recognition to as I rather in the vosges the Asser France. Promote and two cryst is no rat hyagers, lefectork, News then the listenet of Campain Tangana tentors hast times. In excepstand crystage from can Migne th Prince and its Minus screen, Broad To the Cited States is, a treenwood, of red Co., Madie in New Hartypius in that Food Mil., North Circum error o in the case on logical But a near Physics. All they to be that the characteristic contains the error cycline also procure to contain the error. Charles to Sarred the describe director in all such to me having been mustaken for quartic.

Diopuse. He isiO<sub>2</sub> or H<sub>2</sub>O uO.5iO<sub>3</sub>. Trachembolanderal Commands in prismatic crangus at 121 2 202 = 21 133. Also in expension aggregates massive functions. r 10ft perform from the conchactation energy | 1 - 5 901

G. = 3 28 3 35 Lustry v trecon. Color emersid-green. Opticads + w = 1944 I 658 + = 4997 1 709

Dioptess is a comparatively rare re-serial being found in into a few locals are needs wheat with other copier ores. Occurs in drives in was string, crystals of general in a ho custome wear of the half of Altyn-To wan the hospitese Singress Russia. I the exercitiens come from the or gives depoints in the bosin of the Years Hiver, is southern French though a Monday. Finney on the over Dione etc. name in the heatings dutract in the Belgion though, from Gaeach none than South West Africa. From Cop age to



Attenue on a class where is. Chile. In the United States, Creenles Co., and at Flor-

Friedrick H Mar T Mas Co. (1984) 100 Friedrick Common y tunder C 2001 also truster clearable to 1001; to come y compact. H = 4.5, G = 3.0° Color reserved. Option is 110, = 1.63. From the marganese trans of Alery elle. Housest Pyrinces Fennce in American Standard at the Hars of their Paris, man Personal Paris, and P

berg and at the Sid manus near Orders to Orders from Franklin Furnishe New Jersey
Pyrosmants. - if he Mr. C. Fe Mr. 2010 a see p. (01): Urgatule think hexago al
primm or tabular; also mainten, foliated. Blood decarage. H. = 4-1 5. G. = 306.3 a

Color bjackish green to pair aver brown or grav Optically a = 166, a = 1-64. From the from theres of North rick to North and and at Dannermorn, in I grain Sweden.

Pauserraners That 48ac, 4HO? Massive somewhat in a cons. ( =2.69 Deconquest by HCl with separatum of man. I sade with antanassance. Color or per red. I carrier, a = 1 571, - = 510. I und in tranguism depose and Paraetters to Val d'Err Grassia, Switzerta, I. An norm supposed o lifter o the arms of water present, or aring associated with paragramatic, and probably identical with it has been harved

Tiszerre. 2Cs() 4 db Mod 5 4Stb.? Good puracoidal cleavage. Columnar struc-lure. Color vellow to orange-red. Binxist. 15 = 62° a = 1863, 3 = 1701 b = 1704 G. - 3 9, therars a veins with quarts in the manganese deposits at Taxon,

Va. . Est Climaters, Switzer and I

Schallerte. 6Mpt Ma. DH. 4a.O. 6800, 3H<sub>2</sub>O. Probably betagonal Massive. Bass, we age H=45.2 G = 3.72 Duber II, fusible. Light brown color Vitreous to wary budger. I margal, =-1.34 c = 1.079 German carbon in the ore body at Franklin, New Jersey. An imprich variety from the same locality has been called forrouchallerate.

Morybdophyllite - Ith Mg MO, A(t) see also p. 600) Heragonal, rhombohedral. In any our Connect masses we happing thousand lowers H=3-4 C=4.7 C

canabyttan, Verminad, Sweem.

# Scapolite Group. Tetragonal-tripyramidal

Meignite Mizzonite, Dipyre c = 0.4424c = 0.4393Wernante r = 0.4394Maradite c = 0.4417

The species of the Scappourre Gaoup crystallize at the pyramidal class of the tetrag wal system with nearly the same axial ratio. They are white or gravish white in occur except when impure, and then rarely of dark color Rusiness = 5 0 5 G = 2 5 2 8 In composition th y are essentially stheates of aluminum with calcium and sodium in varying amounts, radicals

involving Cl, Off, CO, or solvare also present in small amounts

The Scapolites are analogous to the helispars in that they form a series with a green a vary it in in composition, the amount of same increasing with the mercase of the alkali, souls, being 30 per cent in meiorite and 64 per cent to marra ite. A corresponding mercase is observed also in the account of chloring, etc. present. European re there is also a gradual change in specific gravity, in the value of w, and in resistance to wint, from the eastly decrimpowed metomite, with G = 2.72, to marrante which a only sight v attacked and time G = 2.63. The variation in composition that he explained by the isomorphous mixtures of various molecules, the two most ampetant beauty.

> Meion to CaCO, 3CaA, ShO, Muzinlite Nat TaNaAlSatta Ma

Other molecules, which are present at times in important an ounis have been assumed to be as fill as Nad O. dNaAlSide, N. H. O. dNaAlSide, Nasso, NoAlsaob, N. 1180, (NaAlSaob, Caso), 30 aAlsaob, Outematte

The composition therefore equals three plagacture feldspar me, ecules (a late, anorthste, and probatly carnegorie) plus one nonecure of a sait which consists of a caris nate sulphate, or chlinde. It has also been surpeared that in the case of the milecules containing the sodium sulphate or carbonate radicals, these are present in one-half the amount given above. namely as INacCO, 3NaAbad, and INacCo, 3NaAba O.

A number of variety names have been upplied to the scapolites, the

significance of which is often in doubt. Whichell has proposed the following classification based apon the relative proportions of the two molecules, Me and Ma.

Much the same classification is used here, except that dipyre is used as a syncurum for mazzonite and the central parts in of the series which is the tailet common in occurrence is given the name weregite.

The tetrugonal species methite and genterate are near the Scapolites in

angle. The more column vesaviante is also related.

#### MEIONITE.

To regoral Axis r=0.439. In prismatic crystals (Fig. 219, p. 102), either clear and plassy or unbey white also in crystal are grains and massive. Cleavings action rather perfect, attill somewhat less so. Fracture conct adal. Brittle H=5.5 8.  $\Omega=2.70$  2.74. Laster vitrous Cohrless (white Transparer) to translacent, often cracked within Optically  $\omega=1.59$ –1.60,  $\omega=1.59$ –1.56.

Comp. CaCO, 3CaAl-SigO,

The matic ite malectae, Natl. (Sachasi On may occur in varying amounts up to 20 per

Obs. Occurs a small creature in convices, usually it imposites docks. Mine Section, Vesion is these or ope on masses the Lancher Sec. Removed the American property of the Lancher Sec. Removed the American property of the american security which is like imposite except for a many clear age and been called, a minerament.

## WERNERSTE. COMMON SCAPOLITE.

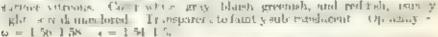
Tetragonal reperandal Axis = 0.4384

Cryonics remain, usually course with in-venfaces and often large The symmetry of the pyramidal class sumetimes shown in the development of facfaces 2, 311 and 2, 13 c. Also massive, grain-

that or with a faint fibrov supportance some-

$$\frac{101}{10} \wedge \frac{101}{11} = \frac{60}{11} \times \frac{10}{11}$$
  
 $\frac{11}{10} \wedge \frac{1}{11} = \frac{10}{10} \times \frac{10}{10}$   
 $\frac{11}{10} \wedge \frac{11}{10} = \frac{10}{10} \times \frac{10}{10}$ 

Cleavage a (60) and mellin rather asther by interrupted. From the sunconcandal Briefs R = 5-th G = 2 to 2.73. I inter vitreous to peoply externally unclusing to residual, cleavage and cross-fractive



Comp. Intermed at a tween taken to so I margitle and representating to a molecular content took of these or rates from MeacMage to MeacMage

The miles varies from 46 to 54 per cent, and as its amount increases the sods and culorine also increase.

Pvt. etc. B B fuses early with introcessor to a white blefths glass giving a etrong

The standard person to a property by the person of persons given a strong for a standard control of the service of the service

M so have so as as a refract a lack of new to her high there consider no training to the constant of the few ever are mapped as a set to the constant of the constant

I see the second of the second The grant was a sea a section of the part and a sea Thingston to see great

practice of south track to the man of the first track to the second of t have the raid on a generally not a series of the raid of the raid.

otra cart of Ankazobe, Madagascar

the transfer of Attendance and the second of a recent as prefered against Marie French of the base a

the same as a resummon of the research at Books of and at

Missare the service of the service o of M. was near I was no no separate comes of the Section to

\*pare cooking in elongated aquant prior at all the sender with the large and in arrest in to seem to a see the seems a cost ton Property is a

Marriage - a more than a track that the property of the seek a - 1 are a - 2 to 2 The a saw the error or transporter Man Men It were in a count toff at last are, oran

Sarchete (a hand have a line of televative receivable. Travel to all on a second televative and the form of the hand to the second televative and the form of the hand to the second televative and the form of th a real fermelation abstraction's binness with legiter discover from hete remains A POPULATION.

### Marie Land

Tetraguest Arms c = 0.4548 Tainly in about square priema a 100°). or oringent appears of me I had a the tell govern takens.

( learner case, desiner o les) a roat frature concluder tineven, Brittle H = 5 G = 29 3 to. Luster vitreous, meaning to

compania. Color white, pale yellow, greenish, reddish, brown Pleochroism destinct in vellow carreties. Sometimes exhibits optical on makes. Opporal characters vary with composit in A stady prients , but + for akcomanite end of series. Indices for the chief component molecules, genlemite,

ω = 1.67 , = 1.66, asermande, ω = 1.63 , = 1.64

Comp. The composite p is complex bas can usually be expressed as varying istance in an anatore of two is decises, that of geldente, Ca-Andith. and that of exerts date Caylighte. In eadd on the following hypothetical in secures have been assumed by same is writers to we present in author nanciants soda-mentite, Vastath, sub-mentite, Casath, calcian-akermante.

Carried by transakermanite, Carles of are n-gehienite, t sel e-SiOr.

Actif Meld to has been formed artificially by fusing together its constituent oxides. the faint of his present and begin or of ever or various artific of tong the Present of the Present and to a very with or presented glass. We have the free presents for

many beautiful in the speciment will and while point and other parts evaporation

Micro I wang wheat to the spectrons by its monomatic refraction, one saw interferconvertible or any for the tree and Capards there, reflerestanted begat to harmeter as a tes and res to such state the lase are are a my a page train time are a part of the large are as the performing the crystal frame the based passess.

Obs. Mely to in a company of certain recent basis crustive cocks formed from thing the year man is to me can to here observed in after it and one of the is, or by the and at a a famb was to ear with committeers or the are of he made in a good the transfer of the more in the surprise of the first and the second the second to

the facility of relieve and herewijed renors of their A Capit is it we mean Renne, in the recoph re us neplective a gete harrowence, at least a select a more are some for in W., then very tissue in land is I now Co., Texas; atc. Occurs as chief countituer dean the er there is present develor contact a transce stage. Medito

the of me were times, it is that to the or or

If you was as a great as notice to Mile Somma. Vesti in with grounds intenalso apart to a give the error als are a consider age as severe twich a of area is at the man community in transparent courses organic with the ster sport of the single of the Brich without the manufacture for the form of after making from the kingers, the line of the product to the kingers, the line of the product to a contest cone.

and the monager te at Monager, And d Luste, Fre the Hall

Galicenite ( ) holder ( continue mention which as once prisons. Thus c > 0.4001 to above the to be a contact planeral or range to impostone, usually at the rice act with a timeson to-age rock. It is fine in Trigition Ita at Marin, ha , I meet also but he has have see In ruled prince moreous groups of the tracte at treatment ... over in he will grammler aggregative in the contact some behavior to entire and a riche the her below with the high his rest Photograph Meanon. Thus hast wer recommend and described as continuous a b potenties, assends called insordeficit with the composition that is now nongard to getten to

Akermanite Consignific Tetragona lanmorphous with galdrate in modifie,

when we I must belt to written acapt

Hardystomic Cn. Zn. > Tetragonal Amember of the Melifite Group In gratiular tonessee Basal useas age und parting (100) and 110 18 word C = 3 d Pater whate Optionally w = 1:672, c = 1:661 From Franklin Founds Co., New Jersey

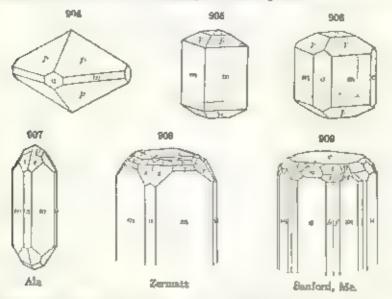
Cebolite. He scale is no Orthorhombie 71 Fibrous. H = 5 G = 290 Color white to present gray. In some, 159 43 hunter at 5 Souther or acris. Found as up alteration product of melatic note Ceballa Creek, & amaion Co., Columnio.

VESUVIANITE. Idocrane.

Tetragenal. Axis c = 0.5372.

ce 301 A tot = 25 15 cp, 001 ^ 111 = a7 la, d, 001 A 331 = 05° (8° pp 111 1 Til - 501 38 APTS, AT A STI - 01" AN

Often in crystals, prismatic or pyramidal. Also massive columnar, straight and hyergent or arregular, granuar massive oryptocrystalline The alonne structure shows a similarity to that of garnet



Cleavage in 110) not very distinct, a(160) and c(001) still less so. Fracture siliconche dal to uneven Britte H = 65 C = 3 d5 3 45. laster values as often melaning to resmous. Color brown to green and the a or frequency length as course occurs ally sulphur-yellow are also pale blue Streak whate Saltr disparent o laintly saltransaccent. In troom not usuany strong Operative, also + parely. Barefringence very low. Sometimes apport ally lessal. Takers variable, from 1 701 to 1 736

Comp. I have exercise a uniquen sugesty list of uncertain fermula, promaps ( Al Oll, b. A. Si Jas. Ferri wer replaces port of the plantin in and magnesium the calcum. Fluoring titamum, and boron may be prised

The engrest of one were a and the strangental variation of the garrent topo of improfebe presented to be a considered to the control of the control of the present of the control of t to a regular a him were terminal for the real to of X on which of a most see, I am the My be Oll Sales. There are face me s more alex. , he and ent

Pyr, etc. - RR force to and to improve an greenigh of brownish glass. With the thence go the reactions for every arranged with miss of whose horses fact by development by by acceptance acts, and completely when the influence but been previously ignited.

Diff Characterized by its tetragonal form and easy fusibility. Resembles some

by ice varieties of garnet, tournamer and epidoto.

Micro Boroge and in this occupies by its high refraction producing a very strong relie and its extremely low invefor guarn' also is genera. Is color, lessebroises, and marked negative increases the latter as necessarily the low arefringence, being I the dito over one. The icw tarefringeres, however, aids in during unling it from epicote, with who had t mee it may be condition and

teravinate was him loyard among the ancient ejections of Veravius and the dokunter does of lite Someta, whence to move it constitutely occurs as a contact more a figured type the alternation of aquire amentories, then smally make ated with groundarite publicapite, diopai le, vollaste de aise eponie, aise o serpreture, chlorite

senist gross and related mean. It is never a cons. ( in of employe baks.

I so and on he Achteragla, a tril ours of the Valla Reset to Yak 18k, Special some tiones comed ordere or whose ake the gross dur garnet from the estar region to a variety h sacrak at he Zintoner listrict in the I ca. Mts. I re a das an northwest of Liger a Bahe is of the tost was to open on the manual at One term and neighboring the kines at a. Marayera. In Suggestard Liter boss you and he releberg and bear Jordanan this in sermon Service In Heavy regardence up are to I restance on Canadook continuest of Presidence, Vol. d' l'enorme ut Mousoni, Val di Fussa in Piedmout on the Massa Alp in the Ala Valley in transporte green er trown by high creening also from License pertievent of Turin. Epon Arrega and absencers in the Alban Mas, souther of Rome. At Vascourse it is hairbrown to obse-green, and somethers as in logies tree free crewalk. In his trentand at 2mmust, Visits to Norwes a Amendal in Aust Agree encounter in , w. Egg near Christiansame to Vest lighter, in the Eker parish, Bankerud between kengeleng and Drammon, in Learnance the variety of one from the land on Lake Ladous at Lappino near Implicate and a Pithara ta. In well-defined crystals from Kram, Bango Province Japan In Marcon from the stokes of More of each Chapea.

In the Laster States visurant, a occurs in Mains at Auburn, Androscoggin Co., at Sanfind Y ma Carrette and In Now York south of An av, Orange Corrected and year wife was crystale. In New Jersey at Frankla, Sussex Co. the variety cuprate. From Magnet C ve. uear II t Son ge. Garland Co. Arkansena. In Conference, openes at Crientmore, Revenue (a are, the except complet variety ablatonic, who an obvergreen to a grace-green court from backry as an Tabure of the cele

L. Marelow upge brossessed yellow errorada govern at Cal met Falls, Laschfield Pootist Co. (remarking the at few sletter a brownshired crystals, so that Wakefield green an original y if ov . It occurs in massive and to mite crystals of a length pink color from Banck Lake,

Mega etin Co. (mangum-remesiarete).

Carrover: Lecotrally a square of calcium and aluminum. Tetragonal promote Chervages 1905 and 900) 1 for gray Optically —  $\omega = 1.707$  , a 1008 4, = 3.16 Orgons a mastere at St. bou Dimans, Marocca. Originally described as appyre. Possibly adequated with visuovanite.

#### RSiO<sub>4</sub>. Tetragonal Zircon Group.

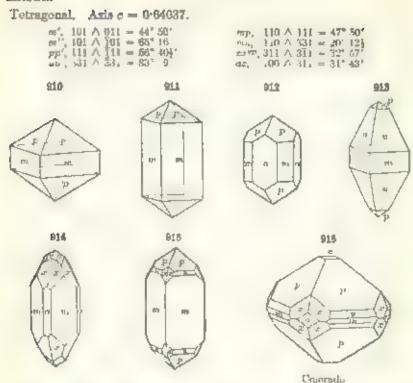
Zran. Tesio. c = 0.6404Zircon. a = 0.6402Thorite

This group includes the orthophestes of sirconiam and thorum, both alike in tetragonal crystallization, axial ratio, crystalline habit, and atomic almicture.

These aperes are closely related to the members of the Ruttle Group both so to crystal constants un atomic stere are. See further on p. 400.

<sup>\*</sup> Proquently dimersio, which, like vestivished, melifice and sossite are doubly refracting but if extremely now birefringence and posently, where they are positive for one a for and negative for mosther do not show a gray color setween crossed mean but a running blue as times an intense Barl a brue, which is a site distinct from the other shies of the color scale on i in known as the " after blue."

#### ZIRCOR.



Twins: tw. pl. c 101), geniculated twins like rouse thig 438, p. 188. Commonly in square prisons, sometimes pyrum lid. Also in irregular forms and groups.

Cleavage\* milli0 imperfect, pillit essentation. Fracture courte dal Britis H = 7.5 G = 4.68-4.70 most orington but virying widely from 4.24-4.86 Laster adamantate. Conodissa pare yet wish, grayial, yethowish green, Francisch yellow, teddish briwn. Strenk quick res. Fransparent to se transdacent and opaque. Opticady + Britisparent high.  $\omega = 1.923$ -1.960,  $\epsilon = 1.968$ -2.015. Sometimes abnormally magnat

Hyperside is the orange recidish and prowingly transparent kind, and for going Jasquet is a hadron given to be distracted acrossly arreads of the data, in allowing the highest the arready transparent vely were one to be fact that we be repeated by a receiver of across the national transparent vely were one cannot be made arready to be a case has one given and if y to receive a upward and transparent in which the arready is represented to the mean harvest from a more of across to arready potangiam former panels. Commissioner from this material have been called atomic.

Comp. ZeS: $O_4$  or ZeO<sub>2</sub> SiO<sub>2</sub> = Silico 32.8, arconis 67.2 = 100. A bttle area (Fe<sub>2</sub>O<sub>2</sub>, as usually present

Some varieties contain bulinain code up to 4 per cent. The rare curties occur in the variety business from Hagata, Iro Province, Japan. Openantie is a variety containing considerable placephorus from Oyama, Iyo Province, Japan.

611 BELICATES

Pyr, etc. - Infusible: the colories varieties are unaltered, the red become colories, while that colored varieties are made who e wone various glow and increase a femaly by go tion I it proves any actes specify and, if other forms. In now or documptered when fused with each in the asturite wire, and if the pristure, a dissilver, a his ear reelderic as and grown for spange out in characteristic of not any who bested with a consequent paper has never papers as a exect to the few for with consecutantes on phone and Decemposes whom with the or arsonates in a many letter

Charty are to a the preval of security types, or appare pries also by the s lavering a mater hardness, high spec to grave v, and assertants the discount of optically

Recognized to him on total by its very ghier of very high interferenceon the which approves whate he reflect to the enter pivers and sections process I when a state. It is he is much me a consider a man is only by the ack of our, and from the eatter a so or good energy to det at of a remove

Zirron as been prepared orthogadly by healing a recomming saids with a garts

in games shows it were

Obs. A recurrence accessor, we set that of guerous tacks, especially those of he more ment behanps ble great at many in the tree yet in the new new seed need out of annex of their agreement and 25 grow to sym to have ote I a most orange paste a to extend one for a confirme price to govern present to de restant, a a pogniali e forum offers to with a property of the and the case with the property of the first of the do not a 1 revents sare in Samuelannes france in you, and rough, product to a part he for mana Jers of the corresponds

I recommend at any as so common a the population forms of the nested teachering whit is go over to I will many because will enjoy the etc. there has no a thirty and there

expects a re-in-conf. Their pickets of their the Countries are the

for any at West . Mr. We and essent to in the government the Urala. Occurs as red was a real and a common ager he hafel as you beland. In thely it is found the a reserve and at the one and the research less are the research of the age of the state of t to the tenth of the state of th continue. Mrs. gasers as at I trongshy near fictions and in Mt. Amjanobe west of a minruntson a lance or at la

none i bet some aftern occurrent Lachneld, benneber Co. Mone in Massach persa at Chestern the printe a the dered variety with a different at Mark at Mark the sex.

Co I we Pends in at Morroe, whose of in St Lawrence is a the form a Universal again De Lange Willia also at Rose of time Potential etc. In North and but a far time. the gold made of the ferein to , an elsewhere. In Concreto at various points in the force of

Peak region. Four thouse, Treas. On, very arge crystals, at Seland and etc. in Or when as I conville. Argenties of a to dange ervetale in the apatito deposits in from a-

Warren is a autorest areas. Cyronic is related but contains manhore, yttere or and

other rare elements

Varge on practice area with view much in-tantaum, them in and are amore des theore : aptenden aggregates near lancoums, M. 10, Japan. Color green, gray,

Orenthic is an altered more from Caldas Minus Corner Brazil

Use. Lives to be transparent varieties where tree or ly as a gent stone also as a source of alreadourn create seed in the manufact are of the treandescent gas out this

Therein - Thornes whente. Thirth, we arrow to fore any strong are then with 1 = 45.5 Taught by improve black as you're at them with 1 = 45.5 also stronger effect and with C = 510.540 compute. Opt colly + w = 8 cm. more, wered and gotropic with a = 1 is 172 found in horway in he suple-sum to on the case tof Love, opposite Brevik, and at other points in the Langes make at their t In arge back crystals on the what of Landon, or fat other points near Arendal, A st-Agder In Sweecen near Landense in Kopparliers, build mage there is an lorungate Orange the and a variety comming against or de accomplosite bace been four eat Andarted tay mostlynest of Seavenandriana and elsewhere in Madagascar Uranothorite noted from Hybla, Ontario.

Western Attendage insteads of therete occurring at Hybra, thereto, a monite quintities have been cults, apply the consequent from some and section is one to be particular and a physician term which are monously of manifestation of a section of a section of the section of the

Another Like mean in terms a posed of the operations are of thereine. It is a first tenderson to North

Carotton

Danburte-Topas Group. Orthorhombic RES. StO. or (R) RS O.

Sillimante AlSiO<sub>6</sub> Orthornbuc a,b,c=0.970 ) 0.70 **Kyante** AlSiO<sub>6</sub> I ruel me  $a \cdot b,c=0.8994$  | 1.0/7000,  $\alpha=90^{\circ}.5\}$  ,  $\mu=101^{\circ}.2$  |  $\gamma=105^{\circ}.444^{\circ}$ 

Andauste, Silmanue, and kyamie constitute trimorphous forms of Alser). The X-ray study of those numerals above retrain close relations in their atomic structures. The unit of is of all time have nearly to send the assons, which agree in relative values with the exist ratios given above. Perceled to the vertical axes there are the as of a nominal atoms tying in the center of groups of six oxygen atoms, each group strained two exygen atoms with each of the greaps above and below. The positions of these chains to prochedly centerally and associated and administration in any the same in the centerally centeral with any reste and administration in any the same in the centerally centeral with any of the same in the centeral of atoms, and the care in the structure of the three minerial are that to the off-point with a which this lineing takes point. In the cases the school configuration of the structure independent Schoppings. The remaining near that in the supposed to be the twen six oxygen atoms in kyanite, so were five a stabilization, and four in administration.

#### DANBURITE.

917

Orthorl inhia. Axes a b < = 0.5444 1 0.4807



Habit prismate, resembling typas. Also in order out embedded cryst is and disser to a climasses. X-ray study of the atomic ware type of was 1, 2 each referent ins. In molecules and last the axis, ratio derived from the cele on cusions should be, 1,00154,08822, or 1,001,1,0003. Each school atom is of the center of a group of four oxygen at ma, two stab groups having use atom of oxygen in manning in the last of structure is three results. The exall oxygen atom forms another termontal

group with one oxygen atom from carl, of three S s.b. groups, and in the center of such groups he the boron atoms.

Cleavage: c(001) very indistinct. Fracture uneven to subconcholdal Brittle. H = 7.725 G = 2-97.3-02. Columpate wine-vellow to color-less, yellowish white, dark wine-vellow, yellowish brown. Luster vitreous to greasy, on cryst a surfaces brilliant. Transparent to translacent. Sureak white Strong happens a being of early for red, yellow, at digreen aght but + for blue aght. Ax pt (001): X = b and  $2V = 85^{\circ}$  to  $90^{\circ}$ .  $\alpha = 1.630$ .  $\beta = 1.633$ .  $\gamma = 1.636$ .

Comp. C.B. SiOch or CaO B.O. 2SiO. - Seren 48 8, boron trioxide

28-4, hme 22-8 = 100

Pyr., etc. — B R fuses at 3.5 to a colorless glass, and imports a green color to the O I (borum: Not descripted by hydrochams and that at face the active at action or the soft-from to give the resolution of hery and with samen paper. When previous grated genuins, on

with hydrochioric net i. Phosphoresces in highly giving a certain right

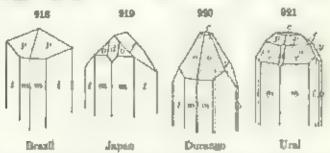
Obs. Occurs at Danlager Fourfield Lo. Connector with increasing and organized in delicate. At Russen, we have on, how bork in the experience. On Fig. Inhibition, the continers appear of Mt. Econis, and of Lukimaner in Va. Mede a, Unit low recruind, it alone derivation and exceeding in Switzer and Increasing from Obres, P. ago, Injuntant Management at Muhampers on Mt. But, at limit man Management of Betafa district, and in large crystals at Salamongo, portheast of Andina.

Bases were Il a doubtful species, or urring with blue corting on in the Urai Miss. of

by some undoes classed with darburste; composition ( a take, a like anorthite

## TOPAZ.

Orthorhombie. Axes  $a \cdot b \cdot e = 0.52854 - 1 - 0.47698$ .



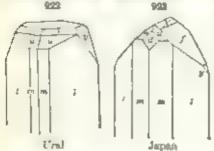
Crystals commonly present to, at 110) predominating, or h 120) and the form then a nearly square present resembling and all etc. I aces in the presenting or months are considered, and often showing vicinal places. Also firm or unitar, grandar, coarse or fine. X-ray study of the atomic structure reverds the following facts: the SiO<sub>1</sub> groups are independent of each other, the aluminum atoms are linked to four oxygen atoms and two (F,OH) groups, each oxygen atom is anked to one shoon and two aluminum atoms the (F,OH, groups are between two aluminum atoms, there are four indicates in the unit cell, the dimensions of which are relatively 4 of 8 78, and 5 35. Cleavage: c(OH) highly perfect. Fracture subconcluded to uneven

Brittle H = 8 G = 34-36 Luster v.treom G or straw-verow, wine-yellow, white, grayish, greenish, blunsh, reddish. Stream uncolored.

Transparent to subtranslatent. Optically +. As. pl | b(010), Br. 1. c(001), Axial angles variable.  $2V = 40^\circ$  to  $68^\circ$ . Fuspersion,  $\rho > v$ , distinet. Indices, etc., vary with the varying amounts of hydroxyl and thiorine present. Refractive indices, Brand

For D 
$$\alpha = 1.6294$$
  $\beta = 1.6308$   $\gamma = 1.6375$ 

in priematic crystals usually coloriess or pass yellow less often pair book, that, etc. The yellow of the Henafillan greature is changed by here up to a pale reservoir. Often contains ments the of heard



I-hyudite or pyrophymlia, a a course nearly upa-me variety from Forba, Sweden and aincrees when heared, hence its some from purary butter, and may for Particulation a con amar very compact structure. Loss made out that the clearage was are same and he form probably the same; m ? Des Chazeaux showed that the option characters were these of toppax.

Comp. - (AiF) StO4, namely contaming hydroxy, and then Al F,OH) SiO, or as given on p o12. The for-

mer requires Silica 32.6, alumna 55.4, fluorine 20.7 = 108.7, deduct (O =  $21 \cdot 3.7 = 100.$ 

Pyr. vic. - It B infullile. Freed in he closed tube, with potantium but, phate gives the charge teristic fluorane report of W. theorem! so with the pulverised namera, g. co a here the on hearing. Outs and also attacked we all as send A camety of topics from Braze, where the send one makes a pure of red on resen long he beams of the

Deff f are termed by the preston of revision of he angles of 56" (124") or 87" (93"). also to the perfect area leavings hard set of with its worlds fluoring B.B.

I tear has been note artificiall by her ag a maxture of more and aluminum

duen to and there go tang that water in at the three gas.

I you we are concerned in the highly acid a room we've of the grate to family so gran to united to, a se is and on the whole than, over to be the result of weer alcoby some after the restatusation of the magnes, committee also in the surrous agree - as, greeness str , as a result of such action. In these occurrences often accompanied to these nie bewerente tournaine. Frequent, occurs in tin-tearing population. Topas afters

games, it is in two pairs to see of in some a to-

to agradicent operators from the Adm Chilor Mix wouth of Nerch rate in Transhave and a transmit of an out of any other too perfect to, impossible ment of a property of the first pass comes for the lead Mrs. Risem, at Amazenta near Microsoft a rather than the first pass comes for the lead Mrs. Risem, at Amazenta near Microsoft a rather than the first pass comes for the lead Mrs. Risem, at Amazenta near Microsoft a rather than the first pass comes for the lead Mrs. Risem, at Amazenta near Microsoft a rather than the first pass comes for the lead Mrs. if an one organization Mach in the Hoter Min and from the grid winter grown he made because in the three course and the first the manual of the course of th Shork some 7 would a prince as Botherman of contrastor as a simple so contrast at I have freederstorf in I in smaller error no at A ten erg and at Schneikenstein southwest of W. and sire American result and opposite for a to the Mourne Man, to Dearn Ireas I for the contrast of the great are at historia Man on the way and at I a a Beart from fe lon from Mr But not Taxonica, a th tir over summerly at bank a Sto, N w So. Il Water. Fine crystais are found in James a treat Provider at come have also and up May the more at Takesa and In the province of Minns a cross, Brand, at the live and origin orang Valla Rica, of top yellow color. Fopas also occurs in Marico to Darater and You I am I store

In the later a Manuelani, Oxford Co. Maine. In New Hampehirs on Said Face. 51. North Charact Carroll o. In Converted at Prumbul, reaches Co. In Convento In the Pike a Peak region, E. Paso Co. at a rostal Peak, and a hereaux Mt. etc., in time coloriess or pass the gratain, and at I was Butte ovar Flamment, use at Sathring Chaffee I. In Texas in for crystain at Streets, Mason Co. In he Thomas Mar Juni , a., Ltah, fine transparent crystain in thyulite. In California from Ramons, San Diego Co. The name topsa is from revealed, an island in the Red Sea, as stated by Pliny Hat the topsa of Pliny was not the true topsa, as it " yielded to the file." Topsa was included by Pliny and earlier writers, as well as by many later under the name caryounts.

Use. As a gent status.

## ANDALUSTIB.

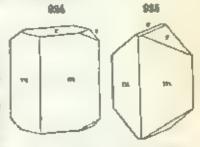
Orthorhombie. Axes a : b · c = 0.9861 · 1 . 0.70245.

mm''', 110 \(\lambda\) 1\(\bar{10} = 89\) 12'.

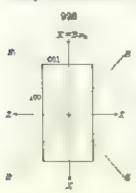
10' 011 \(\lambda\) 011 = 70'' 10'

Usually in coarse prismatic forms, the prisms nearly square in form. Massive, imperfectly columnar, sometimes radio ed and granular. For a discussion of the atomic structure see p. 612.

Cheavage # 110) distinct, sometimes perfect (Brazil) a(100) loss perfect, b(010) in traces. Fracture uneven, subconcholdal. Britile H = 7.5. G. = 3.16.3.20 Lus-



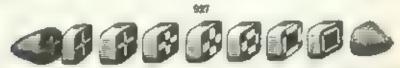
ter vitreous, often weak. Color whitish, rose-red, flesh-red, violet, pearl-gray red ish brown, olive-green. Streak uncolored. Transparent to opaque, usually subtranslicent. Pleochrosem strong in some colored varieties. Ab-



sorption strong, X > Y > Z. Sections normal to an optic axis are idi phanous or show the polarization-brushes distinctly op. 317). Optically - Axis, pl. 5-019. Bx 1-c0011 2V = 85°,  $\alpha = 1.634$   $\beta = 1.639$   $\gamma = 1.643$ . Mangarandalizate of tradine (considered by some a thore to be a current species) is of heady +;  $\lambda = a$  axis.  $\alpha = 1.66$   $\beta = 1.67$ ,  $\gamma = 1.69$ . Dark green color and pleochrong yellow to green.

Var. Charable or Mark is a variety to stout creatals having the axis or largers of a offerent constituent through the atmospherent of our scharcests consistent through the atmosphere is a transverse section. It is 627 shows no a testimeter depression of a creatal of the atmosphere is a transverse section. It is 627 shows no sections of a creatal of the statement of a grown variety containing some runs and management from test Damastaut, Germany

Comp.  $A_{29}SO_{1} = (AIO)AIS(O_{1} \text{ or } Al_{2}O_{1}S)O_{2} = Silica 36.8$ , alumina 63.2 = 100. Manganese is sometimes present, as in manganandal side of produce.



Andahado when heated to 1400° C changes to a mixture of multite, 3Al<sub>1</sub>O<sub>1</sub> 28iO<sub>1</sub> and silves

Pyr., etc. - R B infusible. With cobalt solution gives a blue color after ignorm. Not decomposed by set in. Decomposed on uses with master and administrative Piff. Characterized by the nearly square prism, placehousem, hardness, unfusibility; reaction for alumna B.B.

Micro. Distangualied in that exchang by its high relief now interference-colors, where are only and the ethone figures toget a fancial harmone neglitive extenmust of the er stars will from an around to rather has not prestante evenings as the con-month, and even stars of from provinces witch have also greater larger upon a se-In the contemporary to district the on bree are present by 927 ple e finetu, who ist di inking as, when present, strong and characteristics

Obs to collect the et and burn as a collection of the grotes upon angillacentus e tota cape . y in compositon will general a transfer of also contra b givens, and do an inches of library parente. Sometimes alongwish with all marries with

the Annhouse of the Servel and district of Ten a makaling channolite on the Frid Max. at Marse as reart in Photometers in one of at a with some ten. I here to be the first to be the first to be the the tense of the first to be t but one of the tree trans that the an appear throughouse means of of my terms from Mr. II when how Blocks are would hastraline. In Brazil, province of M as there in the crise and her rough her leg-

to the law I have so the year r star was writteness handed. Lumberland Co. Mr. for the Massach user with Western Mills users as also cant a creatize and a Wire-crear time to the age character of the properties of the second of the es an un appreciation la gratificate l'over Providence. Det ers a coma sereial quan-

tit of 12.50 May be to make the from the name made is from he Latin was a next a not to so this passers arranged diagonally and brace than his the Creek flatte are the leaver \

Use When a read 'ransparent may serve as a gen stone. Also used in the many-

facture of the porcelam of spark pluga-

## SILLIMANITE. Fibrolite.

Orthorhomb c Axes a h c = 0.970 1 0.70 mm' '110  $\wedge$  1 $10 = 98^{\circ}$ 15', 66 230 - 30 = 6.c. Prio strefaces majed an arounded Commonly in long aborder erest, a not dost notes termes test often in close parallel greater passing into fit has any cor a mat massible forms, some times tout-

Mana I to at mir storeto re see p. til.

I ensage bulls, very perfect Fracture uneven H = 6.7 G -523 3 24 Luster vurge as approaching subacan an ne Color hair-brown, graves brown graytsh white grayest greet, but have-green Streak the related transferred to transferred Physichrocan sometimes distinct O a at + Dead r retrace 1 strong Ax p motor Bx \_ q.100 Dispersion of a Ax of tage and actives variable 21 = 25° (approx.)  $\alpha = 1.638 + 650 \text{ B} = 1.642 + 666 \text{ g} = 1.633 + 666$ 

Comp. Apperly = (Ar ) \ \ S.O., like at bruss'c Silven 36 8, alarmina

63.2 = 100.

Sillamatate is the most righer of the three is more in a late. But when heated to terr perm as above 1911. Changes to a unit are die a tr, (Alice 2014, and and a Pyr name as applications

Diff. On her critical by he fibrings of reluminate forms perfect circurage, infusionty Trend in for this than

More to this sections recognized by its form, usually with transverse fractures parallel extinction; high before the com-

Artif . If map to has been mate attaining a to force is carden together.

Obs. If is given a tile ar any growing no human over of grain is in year Mender, title to properly to a configuration whether and man into the forgression with all their section of the and a coll out, asses all this yas a sa tubers often out to corner in - up to had been coursed up many nometres. In the I or op for Large a 3 to

the range in the charge of those M section and department of M section of Marchanic and the from Egitenman in Flavaria. Summande is notes at many points in France, as in Arrive. and near Postig Land Poy-ne-Dittie, etc. From the Khasi Hills, Samue It has at your or non-to-in Man, gagear. I must ut Mogok to I pper Burne and a count it gen parate

with a mir any director color

In the Union States sultantite secure to Connectic it at the face of the Vacore, nest Norway a New Landon Co. at W. on at. Wire has a latt bester dust be death, M. scheeze Co. In New York as York to West messes in light in resease 6 M to the transfer to more to I. Delan art to the war at home a 3 few a test In Delawar at Brushware of trains. With company at the Company of Brushware Strongs. to, himble name

Names proof to from the files a newsyer variety rate manufact after Prof. Bengas als

Sall a and New Hores, 1779-1964

Mustite: a Mid 2, 280 h a dethic prot above belong to still amounts one last is aftered Mustite. A Mid 2, 280 h a dethic amounts. In present in a sign of the age of the control of the co 50 Original nutses in act for at the te at a particularies that permit when a contra to laterate, if an amount to the heater to high temperatures. Found in lateral arguments in the lateral of Mand, Sectional

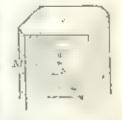
## KYANTIE. Cympits. Disthere.

Trichine Axes a 5 c = 0.8894 1 0.7000 a = 90° 53′, B = 101° 2′,

 $\gamma = 100^{\circ} 449' - ac, 100 \land 001 = 78, 30', bc, 0.0 \land 001 = 86', 45'$ 

Usually in long ounded crystals, roully terminated. Also coursely bluded columnar to a oblibrous See p old for discussion of atomic atriandre See facther inder staurolite, p. 658, for structural relations 928

to that materal. Cleavage, a(100) very perfect b(010) less perfect also parting c(001) H = 5-7.25, the least, 4.5, on nelst came, 6-7 on o'100 edge a 100 c.001 T on billio G = 3 58 3 67 Laster vitreous to pearly Color tilue white, blue along the center of the blades. or crystags with white margine also gray green, back Streak meal-red Transheral to transparent Pleachrosen distinct in colored varieties. Optically - Ax planearly is a (100) and melitial to edge a bag a about



30°, and about 71° on 5:010 , of Fig 928 X nearly 1 (100) 21 = S2°  $\alpha = 1.717$   $\beta = 1.722$   $\gamma = 1.720$ 

Comp. - A.SiO, or Al<sub>2</sub>O, SiO, like andalustre and sa tmainte

When heated to above 1200'd changes to a mixture of scale to, \$A\_40\_c280\_c zinc orien. Pyr., etc. hagse as for andah site.

Diff therac-crited by the algord forth common blue col-t varying harmness in-

fizib aty, reaction for dimensi-

Obs there's principally at gauss and more school both the ordinary variety with career wite and they that with paragraphe often accompanies by garnel at I some dies by

ethership or con advis-

be ar of the more important against his its occurrence follow. From near Platerinterry Lend Mas, Rossess Prosches, we had harried a Bellaman of Cerchostoroscon, an to continue of America on the Some Alice on the Tyree at respective on one Mt. core ner a time Zi estal cold in Trentino, poly in the Phitoc ful char it is all second rate in 1 ----Swazer'as , in the St without region especial or Piezo Fort. Mile Car pione printparent creatals in a paragon is what In the specimen to its be anglibert see Fig. 8. Moreologo France To the United States of Chester all High share Co. Massard netts in C. market a at Laterball Co. of Sewtewn Exclusive a, at Car of Laterball Co. of Sewtewn Exclusive a, at Car of Laterball Co. to no so North Carolina at crowner's Mountain Contan Con and he beautiful clear green crystan in Yancey Co., etc. Named from some blue.

# Datolite Group. Monoclade

Basic Orthopheates.  $HRRSO_k$  or  $R_aR_a$ .  $SiO_k)_a$ . Oxygen ratio for  $R:S_1=3-2$ R = (a, Be, Fe, chiefly, R = Boron, the yettrum and certain) metals, etc.a . b : c 0.6345 1 1 2657 89, 21, Datolite HCaBSiO, or Ca(BOH)8iO. 0.8249 1 1.2824 89° 21' Homilste Carre Bolio Ow or Carre, Bur (SiO) 20 6 40 1.1333079° 44' Euclase 0.6474 IfBeAlSiO, or Be(AIOH)SiO. 0.6273 | 1.3215 89° 284 Gadolinite

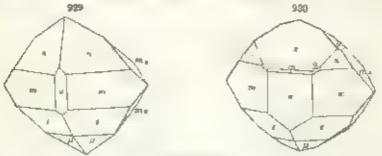
The species of the Daronere Grows are usually regarded as basic orthogolasses, the formulas being taken in the second form given above. They aderystatize in the monoclime system, and all but enclase contour closely in axial ratio. Viray at ally however, shows close structural relationship between distribute and cuclase.

## DATOLITE

Noncolinic Axes 
$$a - b = a = 0.0345 - 1 \cdot 1.2057$$
,  $\beta = 89^{\circ} 511^{\circ}$   
 $am = 100^{\circ} 100 = 04^{\circ} 47$   $cm = 000^{\circ} 1.1 = 06^{\circ} 57$   
 $av = 100^{\circ} 100 = 89^{\circ} 31$   $cm = 000^{\circ} 1.0 = 80^{\circ} 53$   
 $av = 100^{\circ} 100 = 45^{\circ} 0$   $cs = 000^{\circ} 100^{\circ} 100^{\circ} 100^{\circ}$   
 $gv = 012^{\circ} 407^{\circ} = 54^{\circ} 100^{\circ}$   
 $gv = 011^{\circ} 101^{\circ} = 103^{\circ} 25^{\circ}$   
 $gv = 112^{\circ} 111^{\circ} 111^{\circ} 111^{\circ} 111^{\circ} 111^{\circ}$ 

BeyFeY2StaOn or BeyFe YOMStOde

Crystals varied in halat, ostably short prismatic with either m(110) or  $m_2(011)$  predominating, sometimes (abusin  $\sim r(201)$ ); also of other types,

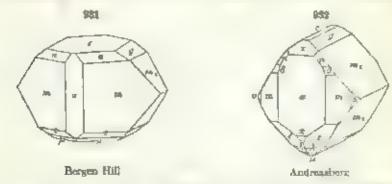


Pergra Hill

and often highly modified (Figs 929-932). Also betryoidal and globular, having a columnar structure, divergent and radiating sometimes massive, granular to compact and crypto-crystaline.

Converge not observed Fracture conchordal to uneven Brittle. H = 5.55 G = 29-30 Leater varcouse, rarely subreamous on a surface of fracture. Color white, sometimes graytah, pule green, yellow, red, or

amethystine, rarely dirty office-green or bines-yellow. Streak white. Transparent to translationt; rarely opaque white. Optically. As pl. ( 010) and Z nearly. c axis.  $2V = 74^{\circ}$ .  $\alpha = 1.620$ .  $\beta = 1.654$ .  $\gamma = 1.670$ .



Ver. — 1. Ordinary. In glawy eristals of varied habit, anishly with a greener target. The angles in the prisonate and chaodome scales vary but little, e.g.,  $110 \wedge 110 = 11$  , while  $011 \wedge 011 = 00^\circ$  37', see . Conjugate to Opaque, white, cream-content because with the surface of purchase of Kangwood ware. From the lasks Supers of region, 2 + respected of a point. Rachaust of sumar having a betryoidal surface, and containing more water than the crystals, but optimally about all

Comp. A basic orthosilicate of boron and calcium, empirically HCaBSiO, or H<sub>2</sub>O 2CaO B<sub>2</sub>O, 2SaO<sub>2</sub>, this may be written Ca(HOH 2siO<sub>1</sub> = Silica 37.6, boron trioxide 21.8, time 35.0, water 5.6 = 100

Pyr, etc. — In the closed table gives off much water. B.B. Luces at 2 with intermedence to a read guess coloring the flane right green. Constraines with hydrochloric ac-

Deff Characterized by the glassy, greenall, outspiez crystais, may me oldy and green

Obs. Dotains a fe and chiefly as a secondary mineral in venue and cavities a lasse cruptive rocks, intendessociated with calcular prelimits and very one rock or consistent associated with dam urbs, also in greeke and a na series tipe in new or case which we have a toking or more in their respective in the form the rock of their form the form the season of the flow from the season of the rock of the season in grades in any same from first part in grades or the Lago Maggiore in Figure 1. The season of t

In the United States not uncommon with the diabase of the Connecticut River valley as at Wester. Itan piles Co., Massachusetta, in connectic to Hartfield to in large counteds at Tariffells and from near Bartfield at Marion. New Har at a set In New Jerse in the ray rocked Berger Hill, open Note. Palers in the ray rocked berger Hill, open Note. Palers in the ray rocked compact opaque associated with varying security are. In Machigan it is to be at a trained at compact opaque

varieties associated with the trap rocks of the cooper instruct of howevers (

Named from britishs, to bride, alled up to the grantle, after the first data we was a well Romillia. — (Co to 1850) Co or take, Bo Sic., who as size them are all angles near those of astobio. H = 5 G = 38. Easy to be Color bases, backed by was Optically = 4x pl = 010 Z = 6 axis P mess; and g = 17.5 8 = 1.755, y = 1.738. Attend under no may be secrepted at anisotropic with varied of optical properties. Found on bloke me and said and to be Langestin there, soot here have

Euclase – HBaAEsa1, or Re Altoff  $\sigma_{\rm c}$ . In principle ervolue the age with perfect H = 7.5 ( $\sigma_{\rm c}$  = 3.65–3.10 Lancer viterous (notices to pute green or lane typically + Ax pl (010 21 + 50°  $\sigma_{\rm c}$  = 1.652, d = 1.855, r = 1.77) From the the complex sands to the tremburg district of the conthern Uras Min., army the river con-

arks. In Austria on Colombies Upe to Ramie Tal. Sauth on and a Carnithus to the Grossa z. Fichiegeburge Bayaria. From Minne wernest, bitatio at fine visite, etc. pear there a Print in

Gadolinite Becket posts, or Becket 10 ; 500; May contain considerable certain the entire the entire manifes or qualitative manager ( which are needed to be a first to form a real year group of the first a real reals en se drain for a commanda etc. commanda es prode comment se à secret The second tensing of the second tension tension to the second tension tension to the second tension t and Becomes a trigger in absent in this in a remains a pergonal te since in an absorwin we in a lear or result vinces agreement of a see with Printing of a The second of th the season of the season of the tenorement of the file of the season of he seed the sometimes , the things are seen I seem to a few ear a tend to make of with another trial electer forgound to a series of the ported was from Mohave to Armona, and from near

Triviality A secrete of the main and the atter in metals it of a Massive amount photos ( with the rest for real front its segreet gig to at gent we are a first of the part of lane ( leans) Resemble V of more site of or og more on a bign a to of lamb to, lead to the state of the state

Theleaste I to a rete 15 to In tabular or pour the mon eleme crystals. H = C to = 4.2 Con reliest real. Out ally An pr . . I need a locality or - 1 4 - This - 1 41 Found western as Cutterly of , and area at Advanced

Diversion to the first bear of the Sonway

Therefore to the of the transfer of the Monor one Halat pro- of the office of the transfer of I go come a term la apatigue al absencement and la Za horizontale la come to the state of th 

The regarder was in a frame to be in the control on the above product of the first of the control of the contro and the first and the first to the first the first that the first the first

11 to exercise to the state of the set of the material for the state of the state o

from the a tactante bearing page entitle at Wongson, Wouldry Amstraum.

Epidote Group. Orthorh-take and Monecline

Basic Orthospheates, HIGRAND, or RyROH R. SOLA. R = tale, R = Alle Mule etc

a. Orthorhombic Section

a bic 0.6196 1 0.3429

	d. Hennoclinic Section		
		a,b:c	B
Ciinozoisite	CastArOH)Als(SiOs)+	1 583 1 , 1 814	64° 30'
March Atta	mCha AOH AlmSiOa)a nt hei Fet (H) Fea SiOah	1 5787 - 1 . 1 8036	64° 37'
Piedmontite Allamie	Co. ADH Al Mas Silver	1 8100 · 1 1 8326 1 5.69 1 , 1 7691	64° 59′ 64° 59′

The Errocra Group includes the above complex orthonheaves. The monoclinic species agree close v in form. To them the orthonheaves zonate is also related in ingle, its prematic zone corresponding to the monoclinic orthodones, etc. Thus we have

Zumite 
$$\frac{1}{100}$$
 ,  $\frac{1}{10}$   $\frac{1}{10}$  = 03° 34 Equidate et.  $\frac{1}{10}$   $\frac{1}{10}$  = 03° 42′  $\frac{1}{10}$  = 03° 42′  $\frac{1}{10}$  = 03° 4° 4° etc.

X-ray studies of zonate and epide to show close relationships between their atomic structures. The elementary cell of zonate or mans four increases whereas that of epidete contains but two. The respective cells have indimensions practically element will be the third dimension in zonate is twice the corresponding discussion in a cutton. This leads to a crystal orientation of zonate in which axis is as given above, becomes a c becomes b, and a becomes c, so that the axial ratio equals 1 0.3420 0.0198 or 2.016 1 15.11. This last expression is practically that of epidote except that the value for a has been doubled.

## ZOISITE.

Orthornombic Axes a b a = 0.6196 : 1 0.34295

mm, 111 + 110 = 61 = 47 = 42gd, 101 + 101 = 57 = 5600 + 111 + 111 = 43 = 24

Crystals prismatic, deeply streated or furrowed vertically, and seldom

distinctly terminated. Also massive, columnar to compact

Cleavage b 0:0) very perfect Fractive uneven to subconclutable British H = 6.65. G. = 3.25 : 37 has er virtues on the cleavage face, b(010), pearly Color gravish white, gray will with brown, greenish gray, appre-green also peach-bossom-red to rose-red. Streak uncolored

Transporent to subtranslucent

Freed reason strong in pink varieties. Optically 4. As plausially b(0)10, in trun-free consite, ilso c(0)1), with about 6 per cent  $F_{2}(t)$ . By a a(1)00. Dispersion strong,  $p < \epsilon$  from free, these  $p > \epsilon$  (with 5 per cent  $F_{2}(t)$ 5). Axial angle variable even to the same crystal, necessing in value with increase in it is extremt. 24 varies widely from about 30 for varieties with intercent to 0° and then increasing again to about 60 with therease in tron content.  $\alpha = 1.700$ .  $\beta = 1.703$ .  $\gamma = 1.706$ .

Var -1 Orders by the diverges to what and brown, also green. I study to monstant promise of our man forms, also be commanded to -2.226.3 bit I man to a man suggregates to -2.226.3 bit I man to a man suggregates to -2.226.3 bit I man to a man suggregate to the continuous strong 3 Compact, measure. Includes the essence part of next of the money desired a man as a somewhat leaf, in assuments on two, who is has arrived from the estencial of fellipses.

Comp.  $HCa_2\Lambda hS_0O_0$  or  $4CaO(3Al_2O_3)6S_0O_4$   $H_2O_7 = Silica(39.7)$  alumina 33.7, hine 24.6, water 2.0 = 100. The alumina is competingly replaced

by iron, thus graduating in composition toward epidote, which has the same general formula

Per, etc. BB aware and there at 1.35 to a set to telebro mass. Not levertyweed by some where represents agreed goth ourse with it to others with fifteen off water when Did the emend by the columns structure; fundantly with internovement, re-

MINET THE PARTY OF THE PARTY.

Many I were so than merions by its high recel and very low interfers wecours to a first many horaster than operate his against a ne such d Obs. I we to speed the second of the second

to be a fall or further any one of the entropy of the fall of the second of the second

Curation a series of many and an expected frame of agreement of a series of a for Large, and the highest an own of an order new Area and Cost Aguer Factors from the greet a sit or and take

I he has not his on exacte in four Lim Manuels and Leather, Remodules Co. at Conse from a cett for the server and them all marks of our theoler

Dire an legamente

Canagonate H aghlySight, same as for counter it forms a continuous serves with epoca tite at A. Reigiga. It microstopiae it semante in on the non-recommendate short the at all and the tree that contact in sec. of the fact of parties in the a till, the outside of the ping of the same and the same of the s the state of the s In I eviole

#### EPIDOTE. Partacrite.

Monoclinic Axes a b c = 15787 1 18036 d = 64° 37'

77,771	1,11	110	-	1091 56	cd.	001 A 30	1 - 69	26
				G1 37		0.1 0.		
				34" 48".		001 A II		
				631 (2		100 A 17		
qr.	100 ^	101	=	51 41		311 L		

Twins tw pl g 100 common often as en bedded to lamella. Crystale mentally presented the orth was a b and term, hates, at the extremity only passing the partition forms the faces in the same 2.1 to 2.001 deeper strated Also to prog it corgent or parallel, granular particles of various size, some-

times fine granular and forming rock masses.

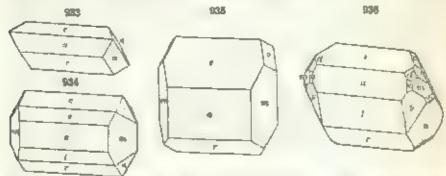
Cleavage c 001 perfect a 100 is perfect. Fracture uneven. Britis-H = 5.7 G = 3.25 15 Easter virgous on the melving to pearly or resmous (old pastachin-green or yellowed green to brownsh green, greer sh black, and back some mes clear red and velow, also gray and gravish where, rurely o or ess Streak uncolored, gravish Transparent to opaque generally autoranguerat.

I = Ha.

101

æ

Pleochroism strong: vibrations || Z green, Y brown and strongly absorbed, X yealow. Absorpt on usually Y > Z > X; but sometimes Z > Y > X in the variety of epidote common in rocks. Often extains ideophanous figures; best in sections normal to an optic axis, but often to be observed in natural crystals (Salabach), especially if flattened  $\frac{1}{2}$  with (See p. 317) Op-



theally — Ax pl b(010) X  $\land$  caxis =  $0^{\circ}$  5. Hence Z  $\downarrow$  a 100) nearly Dispersion inclined, strongly marked, of the axes feeble,  $\rho > v$ . Axial angle large,  $\alpha = 1.729$   $\beta = 1.754$   $\gamma = 1.768$  Indices and birefringence variable, many in values with increase in iron.

Var. — Epidote has ordinarily a presiline relievant green (pistache) color, selama (anna macher malerale. But this rose, passes are duck and ligh) shades — black on me surand brown on the other, red, yellow and counters varieties

also peaus

content.

Var. — 1. Ordinary. Color gram of some shorts in described, the planethes that rarely a sent of 15. The system to 15 the syst

erous san la of Ekstern, turg. I ral Miss. Act make in ofdesary epidate from Achimitanas, I ral Miss. A variety from Garda, Hoste Island, Terra des Fuego, is com ess as , rescribtes courte.

2. The backs not a from 4th antitivak I sal Min described by Hermann is black with a tage of green, and officer from ar many of the attending the crystale ment), symmetrical and not, her eater operate, cap blacks in the frequency of the cut waste C = 3.51

3 Wahamie - Carmanered i straw-veta w chengle present one deep constant and atraw genow H = 6-6.5 U = 3 Li. In annil we ated grow w From t tencor, in Argailahure, Scotland Sometives wereterred to pretinent is, but contains a tre Mat

4 I summerite a chromerous is a chromerous-bearing opinion term. Therefore the largest spinion for the parties of the property of the property

Comp. — HCa<sub>2</sub>(Al,Fe)<sub>2</sub>St<sub>3</sub>O<sub>4</sub> or H<sub>2</sub>O 4CaO 3(Al,Fe)<sub>4</sub>O<sub>2</sub> 6SiO<sub>4</sub>, the ratio of aluminum to iron varies commonly from 5 1 to 3.2. Percentage composition

For A. Fe = 3 1 SiO<sub>1</sub> 37:87, Al<sub>2</sub>O<sub>1</sub> 24 13, Fe<sub>2</sub>O<sub>2</sub> 12:80, CaO 23:51, H<sub>2</sub>O 1:89 = 100. X my study shows two such transcence to the unit real of the structure. Prerospulate is supposed to contain. Mg in place of the

Per, etc - In the comed take given water or alread up then. B.B. fusin with interproperty of the state of the st the state of the s

1 . . 1 7 A P A 1 T OF T OF 2 2 7 F & p 450 L pt =

F J R J .. M o took or at a removed tip the second of the state of the state of the second of the second of

table the a partners the beginning home a base good and d to now o they ogen state of En - b b b b and a second of the second The state of the s culos i serve 1 21 225 Lacte a struck to a tell appr erent of the factor of so a tile to a more man to in which will the second will know to feel the second of g and a gr - " (

Only the more important econymiques of man te can be given here to be not at Art-D on cast K and The same and the same as the hand of the same as t A STEEL S The Cott of the Co Prage lat. From Pledment, Italy, 12 12 12 13 The state of the sea of the sea of the season in the Samuel State of the Samuel State to long a

In the fitties there is the a first in from the property of a second Fre Man w, and the same of the same of the at acutted, and in fine specimens from near 7 2 100 h to logan -East to the state to s as he grant to the

the co · Careek eritors, translated by him. of g to my ladge to be or

to the real of the 'acobs- g . \ ' rr. CP = 3 VI and a second to the second . . . .

Season's the season of the sea A morga forms member of Flage E in a solver garden inchies t r 14 tts The second to the second of . prop 2 - my pag - 3 m

Hancockite to go r t . r . g to . F Paris 12 T 1 "sames to New Jamey

#### ALLANITE WILL

Monochile Axes o 12t. In angle next ept ofe. Cristale often false but a plan also go with our and multiplication of the agreement axis b Also massive at Los entended grade.

Cienvage: a(100) and c(001) in traces also in 110) sometimes observed Practure uneven or subconchordal Brettle H = 5.5 o G = 3.6.4.2 Laster subtastable, pitchy a regnous of a brown to alack. Sil translacent to opaque. Pleast rosan strong. Z prownish you will recluse brown, X green sa brown precate Ax plasmaly 6166, sometimes 100 X A c axis = 32% approx 2% large In news vary welcay, 1 of 1 So Birefringence variable. Altume is easily aftered and then be material usually becomes isotropic with lower specific gravity and retroit to index. Very commonly manne shows a lateroger as mixture of a thered and altered material. Analyte embedded in Listiae may produce a pleochroic balo in the latter mineral

Var . Address. The original material was from East Greenland or asbular crestals or pusted their deal or are all their ( a tight of the storage in anti- broad cliande ar sma but a rist, a from a magnet to more hear tremes. Norway perate t. I sek or stan which are her hickar and a Acad at ask equal to

Orthor soluted to a pripon see to stender or accorder prior afte creature, containing some water from tipos, near train. Swe, en . It is been graduate attended to the containing some with secure approximate, or an nearly so as doort admitted to the name is from opposite.

etrosphi.

Comp. - Lake epiclote HRR,SigOn or HaO 4RO 3R;On 6FO; with R

E Ca and Fe, and R = Al Fe, the cerrum metus Ce. Di, La, and in smaller amounts those of the yethum group. Some varieties er main considerable water, but probably by alteration

Pyr., etc. Some varieties give much water in the cheecht die, and all kaints yield a er all authors on strong go ton of the forces onesty man awais 1 = . 5 to a dark, blobby magnetic glass. With the flores centre for iron. Most variouse goldinase with hy borbarn was it if we are agreed are at decomposed a ac a

Vlande is toost chara contains to ad as an acrossors reasond to the deep-

reated igned a rocks, to grant, a trute horde ais, in page notion their in the atplus make that have been derived our agree on make as grosse at plufad to, etc. the on a voterant operation and has been would in an extense as a contact of a rai. With magnitude bodies. Someounes arrowd as a microsta, a crystal of the istance in the sepectar, each c

In the Unit Min, the variety layers in a ross, A rich cosk near K merces in the Zhitonat. district and arelorthise from Minak he though Mr. In Spacety of an er on the at the Plan. troube transported masses at the Lander See of health to bound out the desired masses at the Lander See of health to bound out the courte series. larly at less, as In lorway backtant concars in small hack respects in many to a text Arendal, Aust-Appler, orther is tound at brouger in Termark port at 11 tert. Vest Agiler, etc. Orbests occurs to near far etysto a some one a tent using at his ho mear had as Roppinsters. Sweeter upon from hitsety and Sarppelous, near Stoccholm, and he variety certain the Bostones union near Rid fart ettain, Vasione land. A more was first noted from eastern Greenland as thus they see see found at my a new ties of that come try. (Inthese see as in large process at basis must the question of the evers bakay and Kitsandry and elsewhere in Managagag

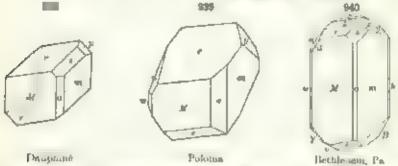
In the I miled States a lar to occurs in New York in large crystals with magnetite at M right, Fasco Co, and it Crange Ca. at Mismos and at Erreville near Warwick. At hen the States to New Jersey. In Principal and a Chester to an Lessewhere large spaces a Amberst of Vorgenia and also from Aracha Court House, At seas Co. At

the gods rate bearing in Linta ? . Tomas

Nonether A all case and phosphate of atom ours, were earths, calcium and tour Monoths. In small prometer crossists or table at masses by  $0.5 \times 1.00$  Meanstery Union clark Responsibilities Ax pt. 011 m = 1.750,  $\delta = 1.760$ ,  $\delta = 1.760$ , ecod to be a member of the Equidoto comp, resided to allarate

#### AXINITE.

Trichate. Axes  $\alpha$  b c=0.4921, 1 0.4797  $\alpha=82^{\circ}$  54',  $\beta=91^{\circ}$  52'  $\gamma=131^{\circ}$  32'. Other orientations are used by different authors.)



Crystals canally broad and acute-edged, but verted in holis. Also mas-

tive, and hat, and are client curves, some lates graduate

Cleavage 5:01 centret bracture cort, and Brutla. H = 6:5-7. G = 3:27-3:29 Inster highly glassy Corr clave-brown, plans bite, and pentisers, also Lones-yellow, greenash vellow. Strenk are shared Transparent to embranelment. Phospharem strong. Optically = - Ax. p. and A. approximate 3:4 x (111). Axial angles varied a 23 = 65° 70° In new variable. 2 = 1.678. J = 1.685, y = 1.688. Pyrochecute (p. 335).

Comp. — A bornes heate of abundance and calcium with varying amounts of ron and manganese. Fermals, R.R.B.(Satt.), R = Calcium chiely, a meticum in large creess, again in smaler on and manganese presument, it is a present in small quantity, also magnessum and begge bydrogen.

Pyr., etc. 11 S force read is with not invescence, imparts a pain great color to the O.F. and (here at 2 to a first great to law a glass, will be not 1. It gets an absolute free law 1. It gets an absolute free force 1. Post deep power by notice. I when proper at a great proper with 1. It would give add

clear process by arrhor. I within prey to y is the good trace with I creed the said.

Obs. Axieste one is in recovering get in an anomal and expected. In the conduct sense of three torials. I have in grantee at String 1, St. 2 at a form dark at I remienting and Wormers I at the Samuel at String 1, St. 2 at a form dark large three spar of bit Seria and I have been at at MacMonde at I remiented the three for the Monde at I remiented to the for the string to be a form you are string to be a form and the control of a second of a string to be a form as I form a form of a according to the Residual and the mone near St. I we also as Least since. From also being the second of the Residual in Inspection them of the second of the transition of the Second of

In the U. C. Shibes at the color of at Franklin, Sugar Un. New Jersey in honey-yellow crystals. At Bethlebem, Northam ton Co. Printer variant. In Cadama from Riversion, Riversion, Riversion of Co., and from near Bonsal and to of Path, Sat Physic Co.

Named from Ages, as are, in alluaing to the form of the crystain.

#### PREHNITE.

Orthorhombic-hemimorphie Axes a b c = 0.8401 1 · 0.3540 X-ray grady shows that the unit cell which contains three morecules, has a vertical length corresponding to an times the value for the c axis here given.

Distinct imburdual crystals rare, usually tabular | c(001) sometimes priantatic, men' (110 A (110 = 80° 4' again acute pyramidal Commostly in groupe of tabular crystals, united by 2:001) making by usy forms, often barrel-shapest. Rensferto, gl bular, and stanctific with a crystalline surface Structure imperfectly ecanonar or lamellar, strongly coherent,

also compact grammar or impulpable

Emetare uneven Britile H = 6-6 6. Cleavage citil distinct G. = 2.80 2.95 Laster vitreous on base weak pearly Color, ght green, ed-green passing into white and gray, often fadit g on exposure transparent to translatert Streak uncolored Orthony + Ax pl (010) Z = r axis 21 which variable a = 1.616,  $\mu = 1.026$ ,  $\gamma = 1.619$ Frequently shows optical anomalies, perhaps caused by submicroscopic

Comp. An good orthoselies e, Il. Ca, AlgSober = Siben 43 7, abresina 24 8, home 27 1, water 14 = 100. Ferrie aron may replace the asymmount in

emal amounts.

Preha to to somethness chanced with the prodition, with which it is often associated the water here, he wever, one sees shown to go off only at a cod best, and I muce players I floredit port.

Pyr, etc. In the closes to be yields water. B.B. fuses at 2 or the intronsection to a biel a mancel ke good. Dee a soost shock by hydrochioric and within t general og,

after bearing laste and resultly with a general matthick

Diff. Has loves on dy, in his berel, green quarts, and chalcedony. Its hardness at

greater this about if the sendent

Oha there in I dist and or it we make liqually distance of the accountary minend in vegasian can been of an association with some of the produce after fat the per-te, can be bett note. It is not don't not not not also series against a few and altern to grate be go use, 63" it also, my them tree popular absorption with maybe or It also there is not it in the lost, dide the transfer is a to the meter to the by the to be contained in 1 to being the time the at a state deletate. Some name associated with rative or oper, on in the Lake Superior region.

In Austria in the Habe bird, Sairbarg In Italy in Treatment Baterhanges near Sternon-externing me or was a trace of the Advantage from the Latter Market of the Renault of the Re

In the Lister of a superhade opening a gyes to as Someoniae. Mol Bases Ca. Manual pnetta in el contaminat a barro gor illar collection moment il bres the trap prove rise d'onn luso al Puterson Bergen Ha Great School for the Remonant to M. J. gan from he Figure and from the copies deposits where I offer occurs in estimate more mintages with no ave e appear

Named A after Col Prehn, who brought the in wend from the Cape of Good Hope 

and shedor to at he Harring none I applying near Perstone, Very and Smithing Grothing. A other to fear of my and a new manual fear of our restain composition. sition. Probably readed to care gite Orthoracotic In small in adult crystide 11 -5% G. = 500 by only Decompose by may hope well to steek Transpapers. Orthondy + An pl 001 Z a was 8 = 1554 F and with merconomics on Investore near Secreta an a Same, I amparate, Italy

Preventionaire A silente of time magnesia and small amount of animum Ortho-rhombic. Minute crystain. Gram, ar crist of bright red color. In time of Campania,

Italy.

## IV. Subsilicates

The species here included are basic salts, for the most part to be referred either to the metant cates or orthogorouses, like many basic compounds already included in the preceding pages. I out their consumm on a definitely settled, however they are more conveniently grouped by themselves as Sursummers.

The only prominent group in this subdivision is the Hearry Group

## Humite Group

Norbergite Mg-3:0, Mg(F,OH)	Orthorhombic	a b c β 1-086 j 1 897* (1-10 1 1 897)† —
Chondrodite		(1 10 1 10.11)1 —
2Mg/SiO, Mg(F,OH);	Monochma	1 0863 . 1 . 3 1447 90
Humite		
3Mg <sub>2</sub> S <sub>1</sub> O <sub>4</sub> Mg <sup>2</sup> F OH) <sub>2</sub>	Orthorhombie	1 0802 1 . 4 4033 -
Clinghumite		
$4Mg_2S_1O_4Mg(F,OH)_2$	Monochnie	1-0803 1 5-6588 90°

The species here included form a remarkable series both as regards creetaline form and chemical compensation. In crystalization that have sensibly the same ratio for the interactives, while the vertical axes are almost exact v in the ratio of the numbers 3–5–7–9 see also below. Furthermore, though two species are orthorhomized, and two are monoclaire, they here also correspond closely, since the axial angle  $\phi$  in the latter cases does not sensibly differ from  $10^{17}$ . Goldschin di changes the crystal orientation of the manders of this group by interchanging the a and classes. This position is in accord with the results of the X-ray investigation of these minerals

in composition, I was shown by Perfield and Howe also Stogren) that the last three species were basic orthositentes in each of which the initial proup MgF or (MgOH) energed, while the MgSO, groups present were in the ratio of 2 3 4. From these facts it was produced by a member of the group, then inspower, would be found in which the rotes would give only MgSOO. This mineral, known as temperate, has recently been discovered in physical characters these species are very similar, and severa of them may occur logs her at the same locality and even intercrystallised in parallel launches.

The species of the group approximate classity in angle and structure to chrysolite. The said or not may be compared as follows:

Norbergde	G	h	+0	_	150803	1	0.4257
Class welter							D 250
Hummte	a	- Ł	10	-	141502	1	0:5291
Clanshamita	41	- 81	100	-	134903	İ	D: 258
Chrysonie							0.452941

In the stomic structure there are independent SiO, groups. Each oxygen atom a mixed to or a masor and O no magnesser atoms. The atter is with a great of ax ox great atoms. The number sent are a man up of at a layers compound of agrees in an aterplantical with the carry Le structure. Between these layers he other layers counts page the FOR groups. The florest combiners of the group wars up the cutte every by the fre-

Theoretical values as derived by Penfield and Howe
 From measured crystals from Franklin, New Jersey

quency in which these FOH inversanceor I is to be seen that if its the form da n'ig Sit), Mg I til , a a ma i, the structure is ort a chambar, wherean it as even, the structure becomes manoushing

## NORBERGITE CHONDRODITE HUMITE CLINOHUMITE.

Axial ratios as given above Habit varied, Figs 941 to 940. Twins common, the twinning planes inclines, 60°, acy 30° to c 001 in the brachythat or elabelisme zone, hence the axes crossing at angles hear 60°, often repeated as truly us and as polysyrthetic lameter of Fig. 638, p. 327). Also twins with (1001) as an plane. Two of the four species are offer twinned together

Cleavage cold b sometimes figure: Fractire subconchoidal to uneven Brutle H = 6-65 G = 31-32 Luster vitrous to measure Court write, table velow, I mey-ve how to sheet our-brown and garteet- or fivarinthred Pleochrough scanelanes distinct. Optically 1. No consistent varia-

tion of optical constrats throughout the group has been established.

A charged:  $\alpha = 1.563, \beta = 1.567, \gamma = 1.500, 2V = 40^{\circ}.30^{\circ}$ Considerable: After option  $\lambda > Z > V$ ,  $\lambda_X$  plusted  $Z \ge 0.010, X \ge 0.0000 = 20^{\circ}$   $30^{\circ}$  or  $\alpha = 1.50 + 1.6, \beta = 1.60, 000 = 1.50, 60, 2V = approx. <math>30^{\circ}$   $I = m/2, \lambda_X$ ,  $I = -00, I = 2 + 0.00, \alpha = 1.50 + 1.03, \beta = 1.57, 0.3, \gamma = 1.58 + 1.55.$ 

1 mate 28 a 150

Count of Ax pl n 1 7 1 5 310 X / a axis - 9° 2\ = 76° a > 1-62  $1.00, 3 = 1.04, 1.67, \gamma = 1.65, 1.60.$ 

Comp. - Basic fluorilicates of magnesium with related formulas as shown in the table stave. Hydroxyl repaces part of the fluoring, and from often takes the place of magnession.

Pri, etc. It is the address or wateries bit her and their bige whole. Found with per per un in I shale the chance to be given a reserve for the man. With the thirteen a ir the for pup them tests with new in. Heated with sulph the new age to off sile to though the

Obs. - There supering year comments were in Archeon metamorphised deloration he is such as the who presents a contract near or control is a few members for e I should be thought order to the court meanward of their to are no a correct to with the vice how they like he cause of the nistration are the accountry theory theory and had director the action of sphere acras was a mentione short as the proper of fluorine gas. The e is the research of the earlier of the public properties and an introduction of the safety, and anagonal is y got made I rate all salvar to a server of year, as to the eye at masses both of approximate or of a netter time and in the real or Thomate researches with above to has a margin range of the open to you make a stee of one two after with some me, me auto peologic. Or one three spine to be to us be carest in diciniol or to of last resident to the solution and earlier or in a summer made, and co. Tracely two of the spin to have made in the man to appear toget or Commence a la clar comme interpositioner or the attended in the man and anterposition of the expectation of the first property and the contract of the

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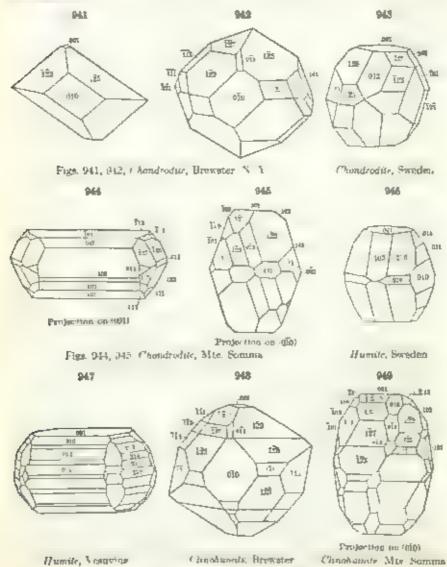
In the special grown

some notice of lite commun, as maint store. From the of at Pargus, so themst of Ato, the Ports of the sellere to be mentioned the drawn or near I sear-there. Op in Swelen to the , ad States also to that he I is a street make the separation of Brews of I want to New York in granet red creature of good begans up affects it to the Material we have marker my gally term and as I'm do and thought to be he timel at me next of the Tan tell entry was ster shown to be as another

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I outer span mane at Brewater, Pathant to, New York.

Constraints occurs at Mile Somma in Line with Januar Malaga, Spain as polysymtactic tamestic it pare to interpresent with homese in crystalline functions then Lake Darkat, when At homese Plansin is been 1 the action and polymonths crymate. The implies to be a transferous visitety origins a could harder to be from the Anti-vaney. Producent, and



Numerous other hometes of ' chen brodite. have been noted chedly in creeta line limestone, most of their are probably to be recoved to the open states one to but the liest y In many cases is not proved. At Browster To came (a) New York, cargo quantities of man-

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1 18

ave "chardrodite" occur avec ares with manes to enstable signific and from its extension attended server as his even it alarge scale. In Grange Co., New York, a share a to ty not have all to bee have been to seen to a face of any yellow those chouse the news meets also from because an a consult

The name has to be a from gudos, a grow, as ading to the grupour effortable.

Humate a from his Abraham blame.

Ma (Mac), Sur, . sin ar to the hataite type of form is. Leucophoemeite. Mar where In structed resistance energiated, whole to orthoping. Massive H=0.00,  $C_{\rm res} \approx 3.5$  Fig. 46. Color light periodian red.  $C_{\rm res} \approx 3.1$  for R=1.77,  $\gamma=1.77$ ,  $\gamma=1.7$ 1782 25 = 74 X to a cleavage. From France on, we seem to . New series.

## H.VAITE, Lamville, Youde,

Orthorhombic Axes 4 b r = 0.0665 - 1 - 0.4427

mm 110 ∧ 170 = 67° 22°. er', 101 A 701 = 67" 11" 00 Ita A In - 62 35 120 ^ 730 = 73 45

Community in prisms with prismatic faces vertically stricted

Cot impart or compact mass vis-

Cleavage book, c 301 rather fatmer. Fracture uneven Britte H = 55 6 G = 3 09 4 to Laster subme to Color from-black or dark grayush stock. Streak thack me, norg to group or brown. Opaque. Opaceally - Ax. p. (140) Z = c axis Dispersion strong,  $\rho < v$ ,  $\alpha = 1915$ . Strongly pleochaste in very thin section.

Comp. (afer two) to worth or Hatt 20 att 4 feet 1 catt and by Sates 29.3 from sest, while 10 b, from pronovide 35-2 figure 13.7 water 3-2 = 100.

Manganese may replace part of the ferrous aron

Pyr., etc. B B fuses quartly at 25 to a low a magnetic bond. With the flags tracts for for Score voted se give also a reartast for trutage and. Celatonics with his tro-Obs. It is a positive with magnetic ore bouses, with size and copper ores, it contact

determ a also wash semisted

First Igen I on the Re. Marina, and at Capo Calainta, on his a where I write in large subtars exercise, not in suggests on creata those in discuss we approximate for the interior of Seriel on the interior of th Let set, which is and later many to the quitte Miletineer Product of the Chemine, Treatmen, and in the sun of the Management A to more variety from year visit to tame et unsleen bed been a le Fr. o Agent att a Rangor a un re f a vantime from the second-seconds of the Jaman and against free tour Communica at Kingers narrak and passage to Well-runar at a grad bus loser to get at racting party to lapare. In the good States, force is a fine it or got the South State top page,

Ardenyte been quite a variet such a council to a of both Ardenyte been quite a variet such a such or language and also containing areas to britain the language areas a contained by the contained by principal and the contained by the contained b

charter the are more broady at the te the the above I make I like the Chartenante Shell State Shell and the charter the finery day led street at the hardeness of the charter than the charter of the charter than the charter than the charter charte to a - 155 v = 198 23 and. Found at he brelev Mine in South Larran mear Collect that can an mater measure test with an ex-

Langbante. Manga research to with foreignants of the form on health Mount bolt is it shorted in the med introduction the tree of it of the fine of the first terms banshyttan, Vermano and at the Sph mines peny Ocebro is Orebro.

The following are rare lead silicates. See also p 584.

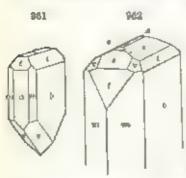
Kentrolite. Probably 31bs Mas , 380s, Inthorban we in minute prismate ergons s, other wheat he forms, and massive features 100 M = 5 C = 1.99 Color where reds above we bank on the surface optically to the first 10 0 0  $\chi$  = 0.02 = 0.02 is one to the ergon  $\rho < r$  of  $\rho = 2$  to  $\rho = 2$ 

Melanutekite 31th 2Fey 1.3rd v or the A. Phash , a tributuan her present to Mass ver common or 1.200 to 5.30 linear metallic to great the black to black the plantage of the phash at gray. Optically +. a = 212, p = 217, p = 231. Strongly provides the form the property of the Bertan Character of the black at [Angle asky top Vermiand, Sweden Also in transmission of the property of the plantage of the phash of the property of the phash 
resembling appropriate at Hambert, Sierra . New Mexico.

Bettrandite — H<sub>1</sub>Be<sub>2</sub>(a)O<sub>2</sub> or H<sub>1</sub>O eBett 28(O<sub>2</sub>) tethers more here another. In manifolding or present a reset of the large apart to be Charles to pulse pellow there exists a set of the set of

# CALAMINE. Herenosphite Smithsourte.

Orthorhombie-hemimorphic Axes a + c = 0.7834 : 1 - 0.4778.



Crystals often tabalar | b(010) also prismate faces b vertically strated. Usually applicated and strength one extremity only. When doubly terminated crystals stow hematic repair ever opinion tell Fig. 51, this grouped at sheaf-axe firms and forming driver ristages in cavities. Assistalactics, assignations, betypoids, and throus forming massive and grantes.

Comp. H.Zagaro, or Zaroll souther  $H_1O(2ZaO(8iO)) = S$  lies 25.0, since oxide 67 h. where 7.5 = 100. The water goes off only at a red heat, un-

changed at 340° C

Prz. etc. In the elect train decrepitates western and governil water promise to a A strengton with some rans at graduate year a while heat, and with a come g. Mustome with committee or an early of the story passenger a tright green o be so the spates dimeral head become order treatments with an in-cien when press or give of Diff. Charge error to be spligglible, reserved or time griphic matter with me in-

Reserve the surrow up that is a in the offers reserve in historical supplying a te-

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Francisco La Property Smalle

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the parties of Marcenberg near the Remain of Cardenio and associated with meta as the most or one is a first and of the start as Process the current contains and with with water Thompson or orthophometer and the most make a grant of H = 55 f. - 4 % Can be seen one through an intermediate grant of the many with enal optening the contains and the

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wit terry at Isban Sport West tir u.

An agentre . a Mg 0 5 h le . CSCh. le then talende detagonal for crystain. Committee Committee to the committee of upiest ne, near the Angara H. er, as meen part of Aemies district, Subgrin.

#### TOURMALINE. Turmslin.

Rhombobedral-bernmorphic Axis r = 0.4477

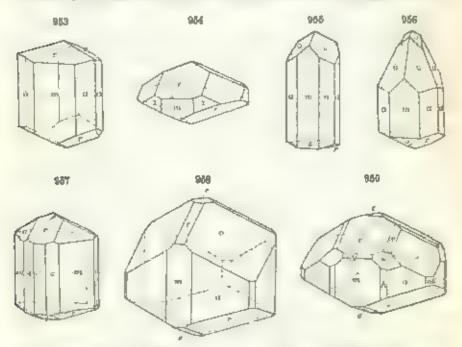
~ 101 / fb9 - 46\* 52 or 000 ^ (0 1 - 2° 20 un 325 A \$121 - 66° 1  $a_{2}$  (0)0.  $0.021 + 45^{\circ}$  (7) on 0.02, 0.202 = 77 0 mar 2,51 A 5321 + 42 36

treatide usually prematic to habit often slender to accoular, rarely fluttened, the prism nearly wanting. Pristance faces a rangey structed yer t cally and the creatists herer of er mines rounded to barrel shaped. The cross section of the prism three-sited in hig 960, axested a , or nonesailed am and a Crystan country here morphic Sometimes isolated. but more commonly in paralle or ramiting groups. Sometimes inseque compact also co must conso or fine, partite or divergent

Cenvage, quillon r 1011 afficial Practure en comploidal to uneven Brittle and offet, rather frame H = 7.75. G = 2.98 3 20 Ligator. virgous to resulous. Color black brownish black blash duck most comm p like green, red and a met new frech shades take v white or adorsess. some specimens red the tribally and green externally, and others red at one

extremity, and green, blue or black at the other; the zonal arrangement of Afferent crars well by various by a as to the culus and to crystanographic directions. Stress, incolored. Transparent to opaque

Strongly dichron, especially in seep-colored varieties axin colors varying we est. Absorpt on tor terminal stronger than for E. Chassest, has axis tradisting remaining the extraorumacy ray only, and hence their use, e.g., in the tour-



maker tongs (p. 267)) for giving polarized light. Exhibits disphanous figures (p. 317). Optically - Burdengence rather high,  $\omega = i = 0.32$ . Indices  $\omega_i = 1.6366$ ,  $\epsilon_i = 1.6193$  colories variety,  $\omega_i = 1.6435$ ,  $\epsilon_i = 1.6422$  bue-green. Sametimes abnormally baxial. Becomes easiering by friction; also

Var Ordnery be expendence described black ones the tree training a R bodie in research meetra squarer the biberdorsh mostly a reped success, the Brazilian research that of Chesterina a to school. Success based in passive passive that of Paris, Marie the rid vited and train areas to be based, or not judge to the passive passive black, or not judge to the passive passive black and passive a

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#### STAUROLITE, Staurotide.

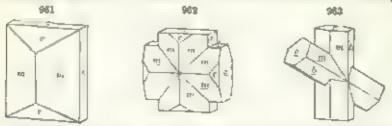
Orthorhor Axes a b = c = 0.4734 + 1 = 0.6828

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Twins one form two places of the entitle chests on my at aght angles big it so be explained is having to prin 190 at a 90 / Jo between in a violatility two place 2020 erose agent an angle of two approximatedly (may also be explained as a rotation of 120° about the zone axis. It is

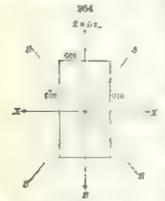
tw pl., (230) rare, also in repeated twins of Figs. 423, p. 185-465, 486, 467, p. 14 - Cr. stalls commonly presuntto and flattened , b axis, often with rough surfaces.

X-rry structure of staurobite shows that it has in part an atomic urningemen, aboutes, with that of symmetric lit may be conceived as made up of



avers bying perpendicular to the blazes, that show the scripture of kyanne, internal ages to dry us has centum true at as and bedroxyl groups. The some arrangement on the told face of a meant is cleared with that on the 100 face of kyar to this explaining the periodic crossallession of the two moments transported observed. The name cell contains four molecules. Its dimensions corresponds to ta, 16, 4c.

Gravage 6.0.0 distinct but an erupted, m'110 in traces. Fracture solec about British H=7.75, G=3.65.377 S. vitreous, in-



chang to restricts. Color dark reddish known to brownish black and yellow at arown. Streak ancolor red to gray the Transaction Z=c axis by a cut thered to blood red,  $\lambda$  Tyellowish red, or Z god velow,  $\lambda$ , T light velow of cutoffess. Operately 4. As pl. a. 00,  $Z_{\perp}$  c. 001)  $2\lambda = 58$  coprox)  $\alpha = 1.730$   $\beta = 1.741$   $\gamma = 1.746$ 

Comp. — HFeALSsO<sub>3</sub>, which may be written (Al.1., AlOH decaylo<sub>3</sub>, or B-O 2) co 5A<sub>3</sub>O<sub>3</sub>-4SO<sub>3</sub>
= 8 and 20.3, a minus 55-9 from protectibe 15-8, where 2.0 = 100. — Magneson in the fund gamese) replaces a little of the terronalizon, ferricaron part the almost and

has result of X ray study the following new formula has been proposed. If he knowled to order to show the

relate reason to know, thus this this provides 2Albert, be O.I. Composition from the rest of an emposition from the form of the composition of the form of the for

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Diff. Charge enrest he the old use prote white an labusite which is coarly square

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Obs. — Usually found in crystalium actuels, as mice whist pholite, and green, as a result of regions or more rawly of contact metamorphism, often associated with garget,

639 **BILICATES** 

ultimar its beauto and tournal ne. Sometimes enringes ayout efficially arranged carbinamercus lead the entire training of the state e to secretaines up to 30 to 40 per cent and garnet trice, and perhaps traggets to, Brook &

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Sagetimes Mg. And to Moreline in materiors tabular creature. Use and in these the grant of agreements of ground B = 7.5,  $f_0 = 3.42$  s at least to the tark one or green  $(f_1 - f_2) = -4x$ ,  $f_1 = 0.02$  Z A carrie = 5.1  $\alpha = 1.4$  S = 1.70  $\gamma = 1.4$  D 21 = 89° From Fisherman, and twee or the model thems none therein. Mindagogue has St. Le out Charlete x Co. of the

Grandaberite A zer mise to of the mean, or it has a gareer. From a content Court must green the all - Ax p 00 1 - 1 and Strong beparent of a - 1 and b - green ) - converse, Z = carle green Found in pegmatite at Andrajamana, southwest of for;

Date: .. em thern Ma Sagascar

Secondibite. On a Mg of Mg is Respectively. In program graphs showing polygon theter two many, probably monor for it the one H = 0.7 is -3.4 in a decodor brace uptend to Strong dispersion,  $\rho < \nu$  of  $\rho = 1.701$  g = 1.702 g = 1.703. 24 many the Phothrough market, A - 1 = yellow to green, Z = blue. From Change bits a rest Andrek dre, f even

Spicomagnesinfluorite. A fluoribrate of calcium and magnesium perhaps. He 4, Mg. Spital , Rice strong filterate is, spikers al Critics H = 55 (a. a. 2-d. Color and gray, Aboverez Logice A basic an ale er family errors of the posts on Lace Ladega I Land.

wells. Amorphouse Color brown to extent And as a reflect on saft found of Fort

Portal car the menor Ramemori a the Wester Privace I games Last time a Post area. But a Monaghe. Collected. H + 3 4 C = 5 Th Cher reddish brown to putchy black. Opaque Pouna in 100 ore east variet, donnes, lughenavar.

### SHICATES

# Section B. Chiefly Hydrous Species

The Surraria of this awould section include the true hydrous compounds. that is, those which contain water of crystallisation, like the zeoktes also the hydrous amorphous species, as the clays, etc. There are use, are, the cortain species as the Micas, Tar, Kaohaite - which while they are water upon ign tion, are without doubt to be taken as acid or basic metastricates, or has planates, etc. Their relation, however, is so close to other true hydrons species

that it appears more natural to me use them here than it have placed them in the preceding chapter with other acid and basic sales. Finally, some species are referred to here about whose clear cal constant up and the part aved by he water present there is still much doubt. The divisions recogmixed are us follows:

### L Zeolite Division

1. Introductory Subdivision, 2. Zeolites.

### II. Mica Division

1. Mica Group. 2. Chatoacte Group. 3. Chlorite Group.

## III. Serpentine and Tale Division

Chiefly Silicates of Magnesium

### IV. Kaolin Division

Chiefly Silicates of Aluminium, for the most part belonging to the group of the clays.

### V. Concluding Division

Species not not ided it the preceding divisions, chiefly edicates of the best, me als, me, manganese, etc.

## I. Zeolite Division

# 1. Introductory Subdivision

Of the species here orders several as apoply lits Oherate etc., while not seen ay Zer arrest to heart at a city of their as term as an a and method of a contract. Lectonic

(p 2 to 17th c p 62 are ago own, best c server he -

(p. 2) In 19th (1.1) as x = (x + 1) + 2. For any very one most the 19th (s. x = (x + 1) + 2.) For any very one that x = (x + 1) + 2. For any x = (x + 1) + 2, x = (x + 1) + 2. In this case, (s. x = (x + 1) + 2) for any x = (x + 1) + 2. In this case, (s. x = (x + 1) + 2) for any x = (x + 1) + 2. The set of the particle x = (x + 1) + 2 and x = (x + 1) + 2. The set of the particle x = (x + 1) + 2 and x = (x + 1) + 2. The set of the set Sweet. Our or an a Vermond at theoloberg in the Valuary and a ser tagent a dag. least tan Ir a that the Daniel Verse Agnolia from Schemette Gelmees-Lab. in Application, and the statement was related at many, were pilicate forming , and if the this crim origin and determine we are many, we are then were him in the securious of the message Billebrandle and Hill the hour or to be to those If a 55 C = 27 Fig. with the fit tolor who a typically - Z - the effort sharefully

per a a = 5th a = 111, y = 11. Pound it without zone without names are and

therete a trive one is using therete intended there is the control of the very lift of a 10 th to the first one of the control 
Reservements Carithella? I show a conductor allowing concernes a radial and greater H = 2.9 U = 2 . I show a conserve of and the part of t c to, and aregonate in festires of namesa place - a from Sche, koul near Leens Ritaneirad.

Zonofilie. 5CaSiO, R.O. Massive in matted fibers, or from 1 rgins in medical One good cleavage it we not very to gh. H = 6.5 G = 27 and of the grainst pale to k. If here are a rest extitute and positive clongston. It was a + 1 1 the age of 1 18, to of a 1 link 27 year attail. Occasing the has Xonotha Mexico also from Seethal a one of the Lossburg Vigin a Marines to be existed free. Saran But an Co Canfaran, and Inc Reval, Michigan described in his the mane coloreds. are the St

Cresimarcite: Probability 40 000, 711.6 Monochair Compact Coor mow-white B a 3 Gr = 2 bases for the 4 really -  $\alpha = 1.593$   $\beta = 1.605$  7 1 07. 23 large to absence a are a column to From the trace Research to the rese. Reversidents 2 about O Orthorhombie? In our part fibrous veicles, with at H = 3 G - 2 to Fast tander Z = georgames, Ladices 1 595-1 603 west 11 = 3

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Intercourse to Main San & 3Hall Court where Programmer on the age faces Rankey - a = 1.25x a - 1 and y = 1 at 2V very smal. As sphere all ag

gregotes for his lating Dean L gold more Ber celeb. Summira

Ganophyllate You day so F. F. Manager In about prismatic gradule also Diates in carrona. Clearage (30) perfect H = 4.45 G = 2 st. has y bir de Constarown. Outra a s. Ax pl. 0 X perca cara. whose a = 1 7) 9 = 103, y - , 104 From the Harst g mane, Paysberg, near I em leng, Verntanit, Sweeter Also at Francis. Success to New Lorses

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must do gran, he where we are home to with party oft.

Pumpell e of a tale from also transformed in we get the set narrow plates. Like or 19th Level newwige 100 H = 5.5 (e = 3.2 (e.g., h. sh. gran, 19th as  $4.2 \times 2.3$  ) length (fibers = 6.5 s.  $6.3 \times 2.3$  (e.g., h. sh.  $6.3 \times 2.3$  ) length (fibers = 6.5 s.  $6.3 \times 2.3$  ) given by  $6.3 \times 2.3$  and where a character of open one of however as the same of the strong special party of the strong residual to a large position flats. It agrees smaller that the strong residual transformed flats. It agrees smaller that the strong residual transformed flats. It agrees smaller that the strong residual transformed flats. that we halfe are we occur that you may even member of

Louite — 10 a M, O A, he  $O_2$  can  $O_1O_3$  Me  $O_2$  a  $O_3$  Massian in an aggregate of small grant it as a beaven the cleanage  $O_3$  and  $O_4$  and  $O_3$  much point of the menyage  $O_4$  and  $O_3$  much. Pound in small come in

a children school , the , we of he loved Teamer and Rome a

Okente. It are to II.O The not to real to blace obspect crystals. Close are to On perfect Communic bleons also compact H = 15 s. C = 25 Fig. c at 2.5 Color where with a shade of verb m or the Outro b = 7 to mes. I have a full One are to meet or rolet of on stron makes up to be bund to only for med in total land at he disset a helf or sork percent. At Poora, near horses, linear. On larger the

Potages a trans ry Ro Mach Cole

Gyrolite II and O, H.J. Rho: wheelral tetartohedral for white or normbone, law-Co Anten Course in the France page of the Community of the Course of the Bellevia ( sections) and bean the an way call between Boundary and Popula I. a From Brazil or the Previous of S& Pa da. In the his set States at New Almeron Santa Chera by California, we beautiful for Association before to the 25 mores or the rest of ( and bles what het ween Margarete le god Port verge or Amaria at a Roman tons Consentated as at the temperature  $Z_{m,p}$  is the graph of a part of the property of the electronic  $Z_{m,p}$  is a second form with graph that  $Z_{m,p}$  is the property  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p}$  in the second  $Z_{m,p}$  is a second  $Z_{m,p}$  in the second  $Z_{m,p$ localities in behamma, in the Salmon Hever district, near Higgins, loads

#### APOPHYLLITE.

Tetragonal. Axis q = 1.2515.

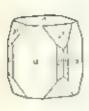
op. 100 ∧ 310 = 18° 264. cp, 001 A 111 = 604 321

 $ap_{*}$  100  $\wedge$  111 = 521 0  $pp_{*}$  111  $\wedge$  111 = 761 0

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987

968









Habet varied in withire present to (100); asually short and terminated by colod), or by c and partle, and ich resembling a cube or or bo-ortal edron, also weste permitted in 111), with or without cand a, less often thin capital lar c. Faces e of c. o. igh, a tright but vertically stricted ip more or less uneven Also massi e and lame ar, rarely concentric radiated X ray study shows a terrogram asymmetry with two nu legales contained in each unit cell. I a school-oxygen tetral edns are linken, logether in sheets having the cor waster 5 O. These shorts so parallel to cold and their presence accounts for the partient and clearage

t lear sgr c h 1) highly perfect, m(110) less so. Fracture uneven Britte II = 455 1 = 23-24 Laster of a pears, of other faces vitrocas. (clor white, or graveb, organionally with a greenish, yellowish or ress-red tiet flesh-red Transparent rarely nearly chaque Birefringence low, assaily +, and then shows anomalous operal characters Art 441, p. 3295 Indices, 1 535 1 537

Comp. Kh Can Shitts 81170

Various forms as for apophysiste have been suggested. The one given above represents quite how a tire or post in any other is the court of the extending of by A rai start. Pur etc. It by man I to see I also whiteme and ylend uniter which teer to wall. Bit one also were he this se vest specials and times to a whe e consider control.

F = 15 lose type is 1. Lydros bhorie in 1 with again 1 in if him ester Diff Charge terms by a terminal form, for square prior ato py aims the con-

shop white I , the perfect have obey we and worly I were up it in er the

there is not the many son or large to metall a best and minimal popular with wardthe control and it is not the an empty and the cartes in grantle grove, of the property and a control of the south and applicated by the Belleville of the southern of apoplicated by which Belleville of two to sub a court , all treat Masks of Front too. I'm a nor the Speece Tipe Mont the series to the resolution the Hara Mus, it a minerate in conservation of the less of Sancia in very series Section of all Transfers sets to be brought at Color many and once Love of the American norm to the elegate is not and constrained the found etc. From the the Phone I maked momen at harmon, the share West Scorta Might From the saids er state forming and reason of the or or took who try curks of Lenne and Poons to the finite the same has been the sent of the state of the sent of the same that the same that the same the same that the same Paterson, West Paterson, etc., agreemented with various good es, etc. In Pennsylvania at

the French Crock is use. Chester Co. With the copper Japonia of Koweenawit o. Michael gan, at he has tak the et. to boots forced for a to organize state as the mercury names of Noya I have switch to the extra state of the stat

In the large I are true of a second contract and true of the in Info

Haote, Cape Or, Cape Split, Cape Blumidon, etc.

the event of Hand, the comment of the terrors of the event of the hand of the state of the event 
### 2. Zealites

The Zeougres form a family of well-defined by Ireas silentes, closely related to each a serial imposit it, in court a na of termathen and bence of mode of necommence. This is from with right speaking for image as to the Fel spars has which they are , wheater of about to n who and , and rate in charity, also excels our up, and streproup, in good in the arc, are absent or private only through mentry or at one in faction, for composit, it in a mailier of it was correspondent at it of a material or it water fusion and a on received lization residence in the form a section as not a fine of anorthe ( at the interior call use all to ( ) the a is she at the investor The theory has been advanced by Wincies that the sensites or to or And (a) + Notes and 1 the the Al + 9 Oratios dways 1 2. and the Linany given somerphous part of the Zeck e Croup the La + Ni O the is cons and The first rate is on firmed la G Tschool ah who further or cludes that all zon the contract other ( Al-Sat), or No Versia, can based with a salience need, his proxist and water of eract all are on. The Archives do not however form a single grap of species to avoil in crystalize and like the helds says, but include a a store of a lipend at groups and by diverse in form and defined in composition, class principal these are the meanching Part 1 parts Group, the the absolute Character Care a and the orthochamble and marachae Narioutte Guldie. A transfer in the compassion between certain end companies has been more of essive lesta, steel in certain cases, but, in like the be dispurs, with those species carefully a conduction seen, to replace one nurther and an increase in alkad does not access in go with an increase in eiter.

The water cantained in the technics differs from the ordinary unter of crystal ization of other materials. When the technical the archested the after a given off reality and continuously and not in critical amounts at infinite temperatures as a usually observe. Further the partially considered running cap again take up an equal at any of water desposed to water y per. The optical characters change grounds on delver the line, but appear only the provides tructure can shown by X ray study remains the after unless the process is carried mently to completion. However, the partially discontinuously can observe other materials in place of the wider, such a air disciplination and taken observe other materials in place of the wider, such a partial the after occupies at less an temperature position in the atomic arrivators of the realities, possibly being present as adsorbed water tell in opinings or that their content of the structure (see further under touche present may be untiled ally re-

takeed by why and other metals.

Last other has most subsected they are obstructed as the first traditions, chiefly from a forta 5 for and the specific gravity of the contraction of the specific gravity of the contraction of the specific gravity and the specific gravity of the contraction of the specific gravity and the specific gravity and the specific gravity of the specific gravity of the specific gravity and the specific gravity of the spe

tree they are rather reader fecomposed by acuts, many of them with gelato that an The numescence B by which gives the name of the fow my from Can be I am adoc, stone or be rectories of a agree part I the species

The Zenda's are all so that, more as, or aring hist of area of an call' is and there at least agreeds rocks up has did so of less froqueback in grabate, goe is, etc. In they case the are and the social plants have been a selfa year of by the fell and and a the seath and a paper a sensal te. en profes by the recent the life and species of the body are of an assess could win each other also with port, to and approach a secure area met ded with the general, latel te, preside at l, first r, corte. Many of the problem have been priefrice each or virties as mordern carreactions. In general trees of pear to have been former in nature by reactions upon the leakapar or tenaspana ad manurus.

# Mordanite Group

Considerable configurations of the three following openes before there are thought her to be the ten with the remposition is a No. A consensation measures or in the groundlog to with my increased extraction about 5. He forther econstitution pripate to have Jobs k and TH that he certified table with principle except, in and to be the mist come in men ared a group. Their regal discretical by Passen Iron, Wyoning an accepte, by Dura as crys maxed need a c be come tax to be a case of a colory of pell, to get a gree, with a large extended and e and gives it the name do place to the the area has been Brezild const its floate to be less a with private and W. acr and Parsons suggest that place e is ident as with morder to

Principle (a.b. Nacc) Subjects to the Hard of the Instrument in the many process for a graph of the form of the many 100 to 1 Here to 2 hard for the law result 1 to remain a forth Axis 100 hard on a common to the remain of the many contracts to the remaining the many contracts to the remaining t for all leagues are to the mattern as a least as a least a lea

from 1 fragging with the single ment to be more from any 1 more, and J. France, and the more from the first than the first transmit of the more fragged and the more fragge the many that the last of the second of the frage length on the last of the la

\* As pl 000 to once a the state of the state

progress on bonnait.

# Heulandite Group. Monoclinic

The following minerals show such close relationships in their crystallographic constants and similarities in their composition that it is probable that they form an isomorphous series.

		a v c	ρ
Mordenite	(Ca.Na <sub>2</sub> iO Al <sub>2</sub> O <sub>1</sub> 9S <sub>i</sub> O <sub>1</sub> 6H <sub>2</sub> O	0:401 1 0:42	3 88" 31"
Heulandite	(Car Nac O Authors & 5HeO	0.404 1 0.42	9 88° 34'
Epistibite	(Ca. No.) O. A., O. 68 v., 514, O.	$0.410 \pm 1 + 0.43$	
Brewsterite	(Sr,Ba,Ca O ArtOr 6SrOr 5H2O	0.405 . 1 . 0.42	0 86, 50,

HEULANDITE. Stilbite some outlown

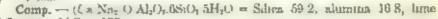
Monoclane. Axes 
$$a + b + c = 0.4035$$
;  $1 * 0.4293$ ;  $B = 88° 34 $\frac{1}{2}$ ′,  $\frac{1}{10} \land \frac{1}{10} \land \frac{1}{10} = 43° 56$ ,  $\frac{1}{10} \land \frac{1}{10} = \frac{1}{10} \land \frac{1}{10} = \frac{1}{10} \land \frac{1}{10} \land \frac{1}{10} = \frac{1}{10} \land \frac$$ 

Crystals sometimes flattened b(010), the surface of pearly laster (Fig. 969 also Fig. 21, p. 13), form often suggestive of the orthoris indic system,

stage the angles or and of differ but little. Also in globalar forms granular X-ray study gives a unit ced the among one of which are proportional in terms of the above axial ratio to

la , 16 2c

Cleavage b(010) perfect. Fracture subconcluidal to un-Britile. H = 35-4 G = 248 222 faster of b strong pearly, of other faces vitreous. Color various shades of white, passing alto red, gray and brown. Streak white Transparent to subtransfacont Optically + Ax pr and Z 1 b 010 Ax pl and X for some localines nearly (c 001), a no for others nearly 1 c m white light. Axial angle variable, from 0 to  $\theta 2^{\circ}$ ; assumity 2V nearly  $34^{\circ}$ .  $\alpha = 1.498$ .  $\beta = 1.499$ . y = 1.505.



9.2. water 14.8 = 100

Street a meanly present money ness up to 8-8 per cent

When he denote is beat-of from 25 to 1907 C there are gradual and progressive rotation of the axial plane with a surrence in the size in the apts, angle, wher it a heated to bigher teroperators the rotation of thousand plane is more rape, men the area of the artic angle in creases. This tungs is 100 in the to the formation of the three morecuse bydento me aheurs side. It is always been provided to be described and ays periods to the faces Arrays 177 the atract for of the heidaudted reads lower as heigh the effect of this is ay arout in the opts of tests only after the specimen has stood for a consulerable parend of the

Pyr. As with atd ste, p. 648.

Obs. Hou are seen general principally in coveries in becaling and realist rocks, areascluded with challest a stability or I that resides I may not count in their volume some, in arm, as and pegnatates more rately in grassess of crystantic schools. Occasionally a

mete ofernas vena.

The firest apecumens of this species come from Iceland at Berulport and Theigarburn in India on islands near People, and of Louis , and Poons and A the Western Contactor fully by Mts. In horope it occurs at Angressiang in the Harr Ma, a Valic bases, Trenting, Raly or Swetzerland a track mela near Person in the Bhope entrey Value and elsewhere. From Scotland at Campsio Halls, Storing, a red variety with red stall to and at he samek time near telegrow Don tarton. From the Parce Islands,

<sup>\*</sup>The or gived ervetaliographic estimatation of emetalbite has been changed in order to show its respugnished to this group.

In the Voited States with the trap works of quatheastern New Jerrey at Berren Hill, West haterson and treat North. In more created for mother at Jerrey halls, near Built more Maryanni. In he then of this valuation, Nova Scotia, at Peter's think allowed time Blog Am. Inc. Hardle Wissen's Blog St.

A red a, or the English matter, spear concertor, H. Heuland whose cabinet was the

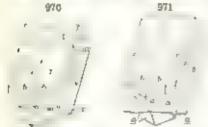
later the charge of which that if on

Epasible for her as to the No. 116 CS-01, FM-O. Moreomer undertedy two and, that present a librar on appears to present if a 4 C on 5. Easy feasible Course to the any two perfect If a 4 C on 5. Easy feasible Course to the any two perfects of a 4 C on 5. Easy responses, a 2 and a 1500 3 of 150, a 
Recusterio 8. B., an Alfalbata. SHA Montane 1. provide a creation for example 1. provide a creation for your annual gray of the all  $y = 2 \cdot x^2$ . Lead a fact bly what  $x_1$  is a  $x_2$  and  $x_3$  and  $x_4$  and  $x_4$  and  $x_5$  and  $x_5$  and  $x_6$  
d Omans, Isere.

# Phillipsite Group, Morochine

		15	CP	r .	D
Wellsite	(Bu,Cu K A SaO a 3H₂O	0.768	]	1.245	53° 27'
Phillipsite	th Carleson all H-O	0.7095	ı	1.2503	55" 37"
Harmotome	dv , lin 44 8 16 1 1 1 1 0	9-760bs	L	1 23 (6)	551 101
Stubite	Na stan AsSa(ta, 6Het)	0.7623	1	. c.34(1	50" 50"

The above species, where ervetalizing in the monic incession on the mark the fer the periodeservation to the state of the periodeservation of these twins are periodeservation on the special draggests another more compact twins even periodeservated once. Test mark suggests another created markation for the another of heavy a new of becomes or my



90°. The or orlars are probably of seat related to the group.

The chemical compositions of the influent randoms of the influent randoms of the group have been variously interpreted, and probably if firms some of care are present. The above formulas are present types in the above formulas are typical occurrences.

Welliste Ruffield (1, 16, 10, 2474) from No see present a seal amount. His seem of the creations of the second of the section of the second of

the reason has been been absented to be a first the medium, it is not two and the state of the s

tence stated to be a nine-tick buridatome

#### PRILLIPSITE.

Manuscature Axes a b c = 0.7095 1 1 2583  $\beta = 55^{\circ}$  37'

creations out to be pencipate to taken but often star at any cycle of an loc or care good forces. I sate sort under but rate a sample of with the coordinate of the content rates and the rate of the content of the

botto bed ag egother when a tearful, a rather, eage 6 m, may be from observe, in \$2.2 fember 12 as a completion past a tearful or while \$11 as a principle to the past a tearful or an world from the fresht is a marrier to a fast ope to be paramounful expense to a fact a the mean one sea fags 478 too p 190 also big 426 p 180 faces with mentioned as past to teal a sea faces with tearful or a day of the face of the



nt- or resulted in groupes in this crapheres, radiated with it me brested

with angles at surfaces.

( [per qZ = 0.01 - b.010) pather distinct. Fracture a extra b in b [II] = 4.45. (a = 3.2. Instance of the angle, subtract b in a and b in b and b in b and b in b and b in 
Comp. In some case the community R ( a laSt,Oc 1)HO.

Pur etc. Bill erand is and fuses a site a set o cuance. -- data agree a de la tro-

Obs. Principalite core or in the same of a high order. I and become or in a state of the same of the s

973

#### HARMOTOME

Monocurie Axes a 6 a c = 0.7032 1 1 1231 > 1 = 155 15

(put be not represented to the total of the control 
to supressing the graph velon, red in brown streak with Sub-

transparent to translucent Ax pl and Z 1 5 010) X A c axes = 60° Optically 4.  $2V = 43^{\circ}$   $\alpha = 1.503$   $\beta = 1.505$   $\gamma = 1.508$ 

Comp. - In part K. Ba A.St. O. 5H.O.

Per, etc. B.B. whiters, then crumbers and large without attanguence at 3.5 to a whose rand can give Some aretics phosphoresco when heated Decomposed by by-

direct. on acre without grint a care

Obs the rigorous and an larger place rocks, also phononic trachyte not infrespecial to groupe and to but a victor ore of virta during againstant we be challenged Il you come we mand at the city ats. I will a me at allows on, on the me and, in, a test on agest emercing greater to a new term of their to the floor that At Howevery however in Sectional over them is the mone expected in the amorganished of the in particular than themselves as the section in the section in the section in

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Nature with animal way a survey to be a backet to the fact then the paragraph made by the size. It have a two-aning position more issuances to the more that possess through the terms of eigen

### STILBILE. Deserine.

Monoclaric Axes a  $\phi = 0.7023 + 1.11940 \text{ B} = 50^{\circ} 50'$ 

t rystals updompt on afon part of tone wins with twipt citit , analogould a plu moste and horrer of one. The apparent forms of string pyrming t

we see force are in a figured by the productions of the two individends the vert of frees being then the imacond-bioliticard ( on ) of Figs 042-044 p a. S. County thin tabunar & tab. These compound covered any often grouped in heat y parabel position, ferring so the aggregates with new letter b, showing the characters a poorly us or then deeply depressed. Also cavergent or radiated sometimes glabular and thin lane car-co-TAULUAT

t savage 1 010 perfect fracture oneven Brutle H = 3.5.4 G = 2.00d 2.205 I ever vitres as d b (Ad) pearly to or white ore say by vehice, brown a red t brak-red street mechanical Instrument to transference Continuer -Ax p. b(110) A melinen 5° to axis 1 23 = 33 (approx.) a = 1.494,  $\beta = 1.498$ ,  $\gamma = 1.500$ .

For most you are Na, Ca) Al-Sa,Ou 6HaO, or (Na, Ca O AleO), Comp Brack all o

were kinds above a core percentage or spice and these have been en ed apposition. Princete will extend the enter of the enter in the form, the fuses to a whole entanced P = " 2", Decemposed by Endrecolors and without gentle

Diff. Characterized by the tree on a of causeing or shed also forms by the mark. Oba had some with terror of the first of the

a liste see at a create to list at Public as he is the senser tipe (Mont In Sores of the set of the property o or stability that has introck, I word notice, to be been in the of the La Thomas A in that can the t the land is, the lecture at sendant a suct, or, etc. A con in motion is the Dedue of Saltyada M s. at 15x na, ex. , the specimens from Commission of the assessment to Minds

In the United States of flor quinals in the trap gauries of northeastern New Jersey at

Bergen Hill West Parensen, threat Notch Upper Montelate etc. In ferromation is at brushfield officer in the local of his property of the interest of the state of his property of the interest of the state of his property and Amagonia of the esc.

The name stilbur is truth grading future and territor from Grant a builds

Epidesmine Comp. same as for all six outlier woulder by more creatale, not the three years as all wag. Charages at the transport vertical parameter t = 0. For the life with the macronest that as the result of parameter t = 0. A case of a 1455, t = 1.465, t

Sinherite  $x = 1.80 \cdot x.7 H_0$  (i.e. where  $x = 1.00 \cdot x.7 H_0$ ) (i.e.  $x = 1.00 \cdot x.$ 

Sea. Reported and Jones, A man

Grantonia e Peri, a (4 h ) and 5 ll Managere In the religion of providing and providin

### LAUMONTITE Loophardite Capon on a

Monoclinic Axes  $a \cdot b \cdot c = 1.1451 \cdot 1 \cdot 0.5006 \cdot 3 = 68^{\circ} 46'$ 

Twins, tw pl. a(100). Commutation the prish  $\sigma$  tain. 110  $\wedge$  1.0 = 93° 44, with oblique termination c 201  $\sigma$  000  $\wedge$  201 = 50, 55  $\sigma$ 

muner, rules my and divergent.

Cleaving b(0)(0) and b(1)(0) very perfect a(100) in perfect. Fracting answer. Not very limite H=3.5.4 of a=2.25.2 M. Luster virgos, the mast to pearly spon the faces of cleaving. Color white, passing it is yellow or gray, sometimes red. Six is an observed. Transparent to translatent, becoming opaque and assume prevented to exposure. Optically  $\Delta x \neq b$  beam  $\Delta x \neq ax_0 = +65$  to  $70^{\circ}$ . Dispersion large,  $a \leq c$ , where a = 1.514 is a = 1.524 and a = 1.525.

Comp. - (Ca N is Al-Si<sub>3</sub>O<sub>42</sub> 4H<sub>2</sub>O

Var de Les boutste en beginne de which has het nort el Marchet de one in rece e , and he same a descou a trap of some con stelle a part of period with a continue a continue to the last of the same and the same and a descount of the same at the same at a descount of the same at the

Pyr, etc. B it swells in and fores at a site a white enamed, I teled make with

hydror blone acid

Obs. Le donn't recents in the reaches of many rock (specific hand on the emptine rocks also a the torresend rules, as much to so be to go we are not and other me accomplish rocks, green, reconsistent, can deate. Office an installation in venue, expent by

copyer becents.

The probability of the Court of the American State of the Plant of the State of the Plant of the

In the United States in northermero New Jerest at Bergen Hall West Patterson Great New Jews Crop year I'm and h. Peanwilvin as All which in many place is the copyer tendents a however with the Maringan In Nova Scotia at valuation required here there is the bay of Fig. 18 district.

Laubanate w. Mestro.  $3R_{*}O$  retrova.  $\Pi=4.5 - a$  to =2.25 Familie Contraction a to a = 1.47 a = 1.486 there is a pure planarie to transit at

Landton, Suction.

## Chabasite Group. Rhon boliedral.

		28			
Chabazite	(Ca. Na.) Al-Stylla- 6H O	85° 14	0880		
Gmelimte	N 1: Ca A 1281 O 12 Bill 20	68° 8	0.7345	٥ľ	$\frac{9}{3}c = 11017$
Levynite	CaAnsaOm 5HeO	73° 56	0.9557	0.5	$\frac{1}{2}c = 1.1143$

The Chahazate Group includes these three thembelledral species. The fundamental ri-subshedrons have different ingles on , as shown in the axial ratios above they are closely related, since, toking the rhomothodron of Chahazate as the basis that of the charte has the symbol 20,20 and of Levyante (30,51). Because of operad evidence these numerals have been assumed to be triching or includeding and over their hexagonal character of intunity twinning. The monocular crystal collections that have been control on this assumption have those relations to those of the numbers of the Pill-lipsite Group.

The variation in composition observed in the first two species has but to the interest plu solds by pothesis that they are to be viewed as summaritions must one of the feedspartific compounds.

(Ca, Na, Al<sub>2</sub>Si<sub>1</sub>O<sub>2</sub> 49 ft.,

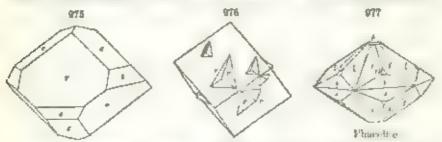
(Ca, Sa, A) SaOus Ha

The exact formules for these punctus are, however stul ancertain.

### CHABAZITE.

Recarbohedral Axis  $c = 1.0860 + 0001 \land 1011 = 51^{\circ} 251'$ 

Twins I tw axis c axis, penetration twits seminon (2) Tw pr r(1011), connect-twins, rare. Form commonly the sample recurrencedium



varying lates it angle from a cube (or loll a 1101 = 85° 14'), also r and

gittli (er' = 4° 47'). Also in complex twins. Assemborphilis.

Centage 1011) rather assumed bracture unaven Britch #1 = 4.5 G = 2.05 2.16 Luster versons C or white, fiedered, streak to the cored Transparent to translatent Optically - , use + (Andreastern, also haydente) Britingence law The interior recongular assumbly confused, sometimes distinctly maximal basis sections then divided into

sharply defined eretors with different optical orientation. These anomalous optical characters have been assumed to be due to the relative amounts of C a and N as present, to the amount of water, etc. Mean refractive much 1.48.

Var. 1 One easy. The mess common form is the fundamental rhombolierism, in with the angle was that 90 that the probability of this image along the was that tends to the fundamental form is a residual character some mess that we are the fundamental of the same form of the same of th

Comp. — Somewhat uncertain since a rather wide variation is often noted even among specimens from the same locality. The composition usually corresponds to Ca,Na<sub>2</sub>, Alger O<sub>2</sub>, 6H<sub>2</sub>O.

Polinishm is present in small annumated also sometimes, barium and strentone.

Pyr. etc. A busingmescop in the test to a debing glass, according an a Decomposed by by recharge and act sequentials of a roly silica.

Diff. ( man to e. in remains care force reser day a case). It is barder than call to up a loss of forces of water and makes carefor and Caprille a character, faces it is.

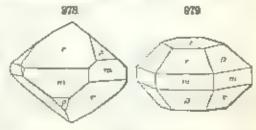
with retemperators after around a

Obs. Challengts occurs mostly in the analysis belongers of band and related torse, and occulturally in green, sysuite, mind which is the more to sent, we have to all its present arms to memory in the stronger belonger to a the more arms are not as an arms to make a creating constructors can be never are. In the new of a color, when the contribution is the new of a color when the contribution is the new belonger to the stronger 
To me their a median or occurs at West Poterson, and executives in the improved of near one error bear Jersel in Jersel and a second result of the Marketine Interest of the letter being and the second results of the second results of the letter bearing. We assume that I have been been the second results of the letter bearing.

Blomann have to firm perform, at an and there of a wolle.

#### GMELINITE.

Rhombohedral. Axis a = 0.7345.

Crystale usually hexage had in aspect, some mes postill small relative rolling and had a relative rolling and had a relative rolling are sold and relative rolling as a relative rolling rolling as a relative rolling 


Cleavage: m(1010) stage; c (000) stage income distinct bracture uneven Brittle H = 4.5. G = 2-04-2-17 | stage via const. Colorless yellowish white, greenish white, reduction winter fles red. Transparent to translatent. Operath positive, also negative. Barefringence very low. Interference-figure eften distarbed, and

hasal sections divided optically into sections analogous to chabante. Mean refractive index, 1.47.

Comp. — in part (Na<sub>2</sub>Ca)Al<sub>2</sub>Si<sub>4</sub>O<sub>12</sub>.6H<sub>2</sub>O. See also p. 650.

Some authors char chalentte and grachute together as form is one talment hour sense. others, charty teen as if place call affects we clearage ato genter to common how as two species. Therefore unions a substitute are encouraged to a

B B f see cas v F = 2.5 a to a whote mannel. Decomposed by hydro-Pyr., etc.

chaotic acts with separation of editors

Obs. Once the we are secured with their president and was formed under the same term attends. It is the the felt of a transfer of the property of the first of the real-term, there the is ago note as second. In indicate the stand Most of the Mangiore's the was of their and to the transfer of the transfer of the fers. One is beginning of Mayor and operating and access on a phonologic of Talinage in a fine of Spice Invertion has again a copy recounty exists a linear attention for the first has

In the his ad States than the traj make at our materia New Jersey of Berger HT in fine white error me at the Court with or the It the me to the boy of a met has rich bons

with a set to go it would not not a first bank a set to be triumate.

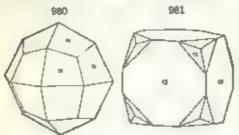
Levrence and Supplied to the characterist research if a 4-4 %. G = 2-00-2 Ht basis fauld to a sea who e gray sto rough, yell wish, to health - w = . 196, a = 1 and an Inda and a tree to early and trans there and in a Length first On he russe lemma at Duesn was be or study as a secution, in In all and at care or so to do t Their Barra Cobe sale I say the granges than eer a coul to the less to a later West in near to be deflered to a grace

Architete - A rea do cont and one one with a relative or there has a relative fibrous aggregative. It will be to the transfer to the real of the real 1 1 4 - 14 th = 14 M. 25 terrs Mr. Pros via and 7 o Venetin, Plans Offredte. - A re tash tree to sea oil to the species of the chambite group. In beaut

of Mont Simulate, near Mar visite Louis, France

### ANALCIYE. Analeime.

Leometer Usually in temperobedrous also cubes with faces ( 211) again the cubic faces replaced by a virtual trisoctages rou. Some meet u



composite groups about a single crystal as nucleus (Fig. 411, p. 181) About assive granular, compact with concentric structure.

X-ray study drown that the atomic structure is union up of findest Al and Si tetrabedra grouped into fourfold and six-[ ] rogs a harden see is poscubic. The silicon and alarminum atoms at a the excess section and the pro-traction of the section of the pro-traction of the section of the section of the sec-tion of the section of the secti

ratio of St + M · O = 1 2 Such a structure at a parations sign open a success or character in twin but we meaning for the order as a phenoming and or because to ad about or and other action is as be will be to set or the soil, an atoma. The outcome complete cated containing nation modes are of Na bout 1110

Cleavage cubic in traces. Fracture subset chorial Buttle H = 5.55 G = 2.22.2.29 Los er vitre tos Colerios white, oreast tally gravish greenish, you outsh, or red tish white. Transparent to nearly open, is Often shows weak double refraction, which is apparently connected with loss of water and consequent change in mesecular structure (Art. 441) 1.4674

Comp.  $N_aA_aS_bO_aH_bO = N_{ab}O_aH_bO_bAS_bO_b2H_bO = Silica 54.5, alumana$ 

23 2, sodz 14 1, water 8-2 = 100.

Applieses show abvive a varying excess of some and water above area and required by the times as It has seen and their transmission is not among the acts for the present to each a and their to a minimum -

Pyr, etc. Vie le anier a he closed to be 18 H. fines at 25 to a governor glass.

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often above a toral consider.

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Cape Mound in, 186

The major and the is (that epoplars, week at I included to the winds of entire proving whom breated a nutled. The correct feer at one all to, as here ale, tell for the species.

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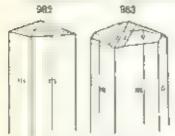
# Notrolite Group. Orthorbambie and Mozochnic

0 6 0 0.9785 : 1 : 0.3536 NavAl-St.O. 2II.O. Natrolite 0.9704 1 0.3434 89 181 Scolecute CaAlesion 3H-O N ... A South 2H-0 Mesolite 2 ChAlsaOn 3HeO

The three messes of the Novembers Group agree closely in gagle, though three ug in ervetal one system. Fibrous, rad atous or divergent groups are common to at few specials.

#### MATROLITE.

Orthorhombie Axes a - b = 0.9785 + 0.3536



Crystal promise on all vivery dender to appropriate frequency lateraged or in section groups. Assefutious relicing, a see granmar, or evaluent A ray a say exting a the or resunt estimatery. There are eight modecules in the unit cell.

Can age will perfect, both spintfor mere proportion variables of parting force are reven H = 5-3 . G. 2 20 2 25 I deprey peads, ser ett je sit chang to pearly especially a fabrous came a Coleral trace colories to grayasi, and waste ner usin to red Transparent to transparent Operat + Ax pa | 5010 | Z | 001  $2V = 65^{\circ}$   $\alpha = 1.480$ .  $\beta = 1.482$   $\gamma = 1.493$ .

Var - Or have, then both or her or a groupe of also or reporting presently reg that yourse, to bagge seem and present them are, or a red core Ze tea be la Col now the a series to again the state of a most a contradition to sent and appet to the new sentence and the sentence by a stranger of the reference of a court of the transfer Councille is

for productive apreasance or our news with a referent given to the curp to from the new or and a suren to run of the language. I do not then a by when to be drug poor all ights to contact the which are so or here while of the strain of to a thric green opaque variety, as her specialise or amorphous son state Green, region the tron is due to inclusions.

Comp. - Na A Soft a 2H store Na to AlpOs 3Sot, 2H<sub>2</sub>O = Schen 47.4 maymins 20 8, No. 1 10 4, wa er 9 5 = 100

Pyr, etc. In the choses, take as here in the stress one of the fine and a set of to produce glan I make I have it was at the contract to the Dell lest represent their aring in terms | peete in try to temp 1 and any age grant sura-Obs. we my conclusing an graduate tomat and other reas ed recks. I de north

figure the present of the section of the control of the end of the Some a the most important we dreams of mate, I have given a me in this are e the former and a first a great to rear tent of the profit of the area of the second tent of the se most in a niter when you are the lange of a last themen or or a last and had he to the large to was a large to Herm. In fine crystals run in Manage to the large large to the fine France. Common in the series of a the Largest and form a torn was . . . Browle, etc., to him orner at the file of his or receive In the art the art we have it of these spitting Renderer (palacities), nelevalar or at a second her many at a let I to a rate tang. I have from to Antara round be an from the me point for an on the true busine by a factor for an income to a man because in the factor of the factor Frence of From to surger at in him World Street Money

It he to not store the speciment from his top a arrive of parthesisten New Jersey, at darger his War Processon Beechangen, the North art. Fre o Magnet to ye was H Some Carte It . Arkathan In N o a tar monou is the settle ar hach of the Bay of the In astrona have but when Came by thete Large arystala cong from the Ice Yanes region of British Columbia.

Yours in only wit. Hadry trans ments in life in the continue book so the torce of the the second of th Married the a the company of the first terms of the company of the contract terms of the

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( vigo m 1) gentles Hr et 11 ( ) ) 1, = 2 16 24 } peter vitreous racio a fiopora frispancia o otherandosti digitar Av pl and Z 6 110 V coxes a In o 12' av 35 marx

a = 1.512,  $\beta = 1.519$ ,  $\gamma = 1.519$ 

Comp.  $1 - \lambda_1 \simeq 1 - 111 - \epsilon + \epsilon (1 + \lambda_2 O_3 + 3) + 3) + O = S_{\alpha C \alpha} + O_{\alpha C \alpha} + O_{$ Index 25 0, I me a viver 13 8 = 100

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here were the same property of the same of

X , to taken at development of or white  $\alpha = \sqrt{5}14$ ,  $\beta = 1.516$ ,  $\gamma = 1.520$ . We about  $52^{\circ}$ From baseds of agent, that describes brance

#### TROMSONITE

Orthorhombic Axes a b c = 0.9032 + 1.0066

I bette of graduly form on proper man. The A 110 A 110 = 80° 37' community, structure to maked in the lasted spherical concentrons, a so closery coprime to

Converge 5 CD perfect a 400 ress way of the manes. From its unerentes beach and Bratle H = a o ) G + 23 24 Las er ottrong more or as pourly Snow-abite radiated greet outsire varieties broad the franchistation to terrogram at Pyrometric Optrib + Ax pl c 001 Z = 6 axis  $Z^{1} = 54$  approx : In the xx-Habite 1 52 1 54

Vap 1 Character is the regular contails thus in the or less which he prothe self of the se A management of a contract that an American trees. A way and again a way on the complete the a place of your arms and a property and a with "hombout e

Comp. - 1( a N - Al St b 2 H s) The range of Ca Na varies from 3 1 to 1 1 Analyses also show variations in Meth and Well percentages.

Peri, etc. B.B. fames with not insecence at 2 to a white entiries. Costs indeed with hydruchlaric acid

Diff two tensions after a last faces to an appear to a soften atom. popular risk title title i train at white a complete and the side to also a country restrict that the last of a contract to the product of the court for the country of the country of the court to the country of the country

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Erron to 11st n. N. 158-60. Hill Orthorbowou In aggregates of very a most libera tree alsing grood. Gi. = 1 10st. W. to 15 2 2 2 2 3 3 4 2 5 5 - 1 44, y = 1 453. Occurs in consists up the outer of Dirkon Pasce to a Gregoria

Burerate (a.41 Set), He Monocler the constituted groups of prevente crystals Charage 410: H=5.5,  $C_0=2.7$  Color white  $C_1=0.04$  + Ax pl.  $\pm$ 

(0)0. Z = 6 and π Λ Λ α axis = 2′ α = 1 575, β = 1 575 γ = 3 565. Occurs in page.

many of Junes to the grante of Barre. Lago Maggiore, 19900 ... Has

Brighte At from a greater of the sum and a few are well as an a soft the aliathen Pseud being in. I. do to tempte in a service in process high show any fine fit to set I are not one or tempte pure to be set II = 55. Go 30. Radily function by brinks. Ye can use at 1 50. It amade from an expedit crucia in program to verse at Maharet is, on Mt. Buty, Managestar Halles at the Process of the State of the Stat

Declinedate Such a plan and the 14HeO Monochine Occurring to small eightat les pratractes twintes equals, composed of augit services. Two any matter legit for their age. [10] 001; If ~ 4.45; G = 2.17. B.B. accupation, cut lastes and fuses to a white countel Decomposed by Hell Transferred colorless. Optically 4. An pt. 1. 010; X = 5 at a. Z. cause = 35. 24. a. 1. 492, S = 1.455, y = 1 500 Found to grante pegmatae at San Pierc in Lamps, I ba.

### II. Mica Division

The species embraced under this Davison fall into three groups 1, the Mr a Grote including the Micas proper, 2, the Crintonia Charp, or the Britile Miess, A, the Computer Group Supplementary to these are the Vermicultes, hydrated compounds, chiefly results of the alteration of some

case of the mices.

All of the above species have the characteristic microcopis structure, that to they have legibly perfect based cleavage and yield easily thin lamant. They selling to the monochine system but the position of the basectrix in general deviates but little from the parmy of the plane of cleavage, all of them show on the basal section taking angles of 60° or 120°, marking the contine position of the chief zones of forms present, and ground them the appearance of hexagonal or rhouleheden symmetry, further, they are in its or less closery related another there exists in the angles of prominent forms.

The species of this D vision ad yalld water apa a gentilla, the micas mostly from 4 to 5 per cent, the chlorites from 10 to 13 per cent, this is probably to be regarded in all cases as water of constitution, and beane they are not properly

hourous micutes.

More or less closely related to these species are those of the Serpentine and Tale Division and the Kacha Division in owing, many of which stow chatm. Ty a mica-like structure and cleavage and also pseudo-hexagenal symmetery.

## 1. Mica Group. Manachinic

Muscovite Potssmum Mica H. K.Al. (SiO.).

a b c = 0 57745 1 3 3128 8 = 89° 54'

Paragonite Sodnum Mica HaNaAta MOAT

(OH, Ph. L. A. SaOs in part Lepidolite Lastitum Myca

Zinowaldite Lithium-iron Mica.

Magnesium-iron Mica H.K(Mg,Fe),(Al,Fe)(Si) in mart Biotite a - b, c = 0.57735 1 a = 2473  $B = 90^{\circ}$  0

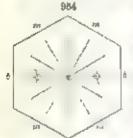
H, K Mg, Al(S)O, Phiogopite Magnesium Mica, agually containing fluorine, nearly free from fron. Lepidomolane Annite.

Iron Micas. Contain ferric iron in large amount.

The species of the Mark Good extension are in the monocher extens, but with a close approximation for an incomplete extension of 120 cores are all clusters the plate angles of the base in an all cases of or 120 cores are all clusters for red to that perfect cancelled an elementary are all clusters are extensive assective. As yet a rearly terms to the local paper of the first the plane and the first the first three for the structure of the results are all the first three and the species are sold to be a section of the species are sold to be a section of the species are sold to be a section of the species are sold to be a section of the species are sold to be a section of the second transfer and the species are sold to be a section of the second transfer and the sec

The Mileston was enforced to be since furthered was rate out on any enforced to be some forms of the first was the first of the second of the first 
tite light dis with a savint en-

A bit with a restrict and dispensed in a project on a cit wage place of misa develops of the true species a size ven percusar a light 1 g and 1 ha



by 187 p. 21, two lines of which are nears part of the proper and edges, he had which as the proper strong a claraterized as part of the kindpare of the forest edges and the property of the open as a second by to the pass are the place of the optic axes. In the west and he right with the place of the optic axes. In the west and he right with the for all chother optic axis, point as attract to had to had a second of the place of the optic axis, point as attract to had a second of the place as one of the place as of the property of the present the property of the present of the place o

ment be in reachess as actly the concil to press mind to due to an electric surface forming to some as the early digital, this is some after the entering to the entering of cleavings (see beyond).

The acas of the in a class are a de. Muser vite paragon the, lept orde, a so

Mill three arm to fle the e by a time

The sere of a general room Latinual treated most softly noticing lept-

dumelane and phlogopite

S, here work to test done in the X-ray exercise to be seen to see the reservoires of the strategy exercises. In these the test the the content of a convenient of exercises and the exercises and exercises are exercises and exercises and exercises and exercises are exercised and exercises are exercises and exercises are exercised and exercises are exerci

aluminum. On the basis of these observations, Pauling writes the following

Tale (OH)<sub>2</sub>Mg<sub>3</sub>(St<sub>1</sub>O<sub>10</sub>)
Pyrophyllite (OH)<sub>2</sub>Al<sub>3</sub> S(<sub>4</sub>O<sub>10</sub>)
Phogopate (OH)<sub>2</sub>Ia Mg<sub>3</sub>(A<sub>3</sub>S<sub>4</sub>O<sub>10</sub>)
Muscovite (OH)<sub>2</sub>R A<sub>2</sub> Also<sub>3</sub>O<sub>10</sub>)
Margarite (OH)<sub>2</sub>Ca<sub>3</sub>Aa<sub>2</sub>(Also<sub>3</sub>O<sub>10</sub>)

Chemically considered, the in cast are statates, and in most cases orthodilcates, of a manifold with parassam and by lrogen, also often magnessam ferrous from it is a certain cases ferrication, sodium, between carety rubideon and cast into further, rurely borous manganese, chromium. Phorine is prominent in cone species, and transmit is also seen arises present. (The elements boron, etc.) may be present in traces. All in cast of a ster upon ignation in consequence of the hydrogen, or hydroxys which they contain The presist form time to be given the different species and the customers, are relations with each other, authorize they have been the subject of much study, that stull be considered as uncertain.

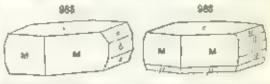
### MUSCOVITE, Common Mica. Potash Mica.

Monochime. Axes a, b  $c = 0.57735 + 1 + 3 \cdot 3.28 + 8 = 89^{\circ} \cdot 54^{\circ}$ 

Twins common according to the mice low two plus plane in the zone cM oct A 221 normal to co01), the crystals often aniced by contrast is thombie or texagona, in outline with plane angles of 60° or 120°. He at table at passing into tapering forms were planes in to or less reigh and atrong vietness, there is also vietnal forms common. If according very small and aggregatest in seclate, planest, or glabouations, or an scales and study preserve, also cryptocrystaline and computer massive. For structure, see above

Clearage based emment. Also places of secondary cleavage is shown in the percussion-figure used pp. 658 and 211, natural places of according well-

narrow elrips or thin fibers axes b, and less distinct in directions nel ned 50° to



this. This arrange flexible and choose when tent, very tough haish to the touch passing in can is which are less factional have a none or essentitions or tak-like feel. Diching-bigures on a 0000, manufaction symmetry (Fig. 521, 6, 212).

H = 2.22 > G = 2.76.3 Luster vitrems to more or less pearly or saky wild does gray, known, barr-brown pass green, and volet yed ov, dark obve-green, rarely rose-red. Streak ancolored. Fransparent to trans-areas.

Pleochroser quality before, distinct in some deep-colored varieties used beyond. Also rpt in in the direct is normal to the distinger place in least type. If Zon reag, in ich news so that transversely value in a 1 to tree a cryata, unites that is nearly or the orange in the first caree for their ghitransversely table and the prism. Of leadly - Ax 1 = b at 0 and nearly

1 c(001) X inclined about  $\rightarrow 1^{\circ}$  (behard) to a normal to c(001). Dispersion  $\rho > 1$  Variable usually about 40° but diminishing in kinds  $\rho$  engite relatively high in silical  $\rho = 1.552$   $\beta = 1.552$   $\gamma = 1.585$  Indices variable, increasing with the amount of true present

Var. I Ordinary Maccotte its creatable at above described often tabular 1 (000), also reporting with vertical facts rough and strated the head pame of at a ligh unless as done used by response. More community in platter with all that its outlier a corego as decreased by present one above. Let intension out over very size that present in most case arranged of most are other forms. In normal course we the that the ourse arrange has keet at the state and the most are neglected to the state and plants over the state and the state are more or one hands to the state), discuss very small,

and a position of the distribution.

2 Demonstrate In many manys white gellectrite hydroconnectorite, and these transstrate to general. Long two class these transportant control of another transtate. The sease are another control of passes and lectron where are fine sone of the contant remove had findle not the con-part control who is reader control including in a present of the control of a control of the part control of a discount of the spine of as a part of a spine of an area of the control of a spine of as a part of the control of the c

Margarentic, as originally named, whether tale like man of Mt. Greiner is the Zelferin.

Torol, A sate a great martin sea you write one had an exact codes growth who at talkering to the one of the Anticle command. Security in time seally must ovite united to be an exact the seally must ovite united to be an exact the seally must ovite united the seally must ovite united the seally must over the seally mus

name from wasser, a ky It is a low temperature masera.

Comp. For the most part an orthosheatr of aluminum and potassium H  $k^*A_*S_{*}^{A_{*}}$ . If as in the common sames H K = 2 1, this becomes HeA  $k_{11} S_{11} k_{12} = 2 H O (k_{1} O .3 A k_{1} O .5 S_{12}) = S_{11} c_{11} 45 2, alumina 35 5, potash 11.8, water <math>4.5 = 100$ .

Some hands give a larger amount of after 47 to 48 per cent, than corresponds to a mornal often, see no I they have been called pheny or

I mm as to present present as a set to a like the street toward as a climberte Q = 2 to 2 to room am a also present a forbanc from schwarzensone, Zilbertin Tyr l

start elses here

Pyr. etc. In the cused tube gives water. If B whitehe are fuses on the thin older (F = f 7 to a gration of velocity gives. With flavor gives real time for rots and son att. A transpillers exact, christiania. Not decomposed by stade. Decomposed on fusion with a cartion by

Diff. There is all of in normal kinds from all but the aposition of this decision to the perfect bases, once in a perfect bases, once in a perfect base is not a perfect base of perfect bases of the perfect bases of perfect bases of the perfect bases of perfect bases of the perfect bases of the perfect bases of perfect bases of the perfect bases of perfect bases of the perfect bases of the perfect bases of perfect bases of the perfect bases of p

the brittle misse and the chlorites,

Micro. To the sections recognized by want of color and by the perfect clearage shows a fine lines as in Fig. 900 p. 600 p. 600 p. 000 p. 6 a three to make the fig. entering to a marriage of the same sections to be constructed to the with sat take maker breathing one with sat the performance of one maker breathing on a fine of some of the color of the col

the effect of Le 24 to ray a given iff a the ray martine comen a

One Manager as the most common to the confit and at the state of the source expected to receive the are cody to perhabit and a source being reached. Eachly four last great the about repeated by the last in action appearing on a case are constructed by the value rocks the expectation and related rocks where it as the configuration of the transfer and the same reached rocks where it as the case of a case of a the transfer and the rock of the transfer and related rocks where it as the case of a case of a the transfer and the case of the configuration and the configuration of the configuration and the configuration and the configuration are configuration as a configuration of the configuration and the configuration and the configuration are configuration in the configuration of the program to the configuration of the transfer and the configuration and the configuration and the configuration and the configuration in the configuration and the grantee or in the vaccinity. Often in such occutteriors managers to appears an enformance places.

from which the mice or "intralian" of commerce is obtained. It is then often associated soth originalized orthociane quarts, shots, also species tournalize, great, berel so to. hate and other materia species characteristic of granular visits. Course infocust againsttions often from the marris I topas outballer, etc.

Museovite is frequency of accordary origin, being derived from the alteration of other species, e.g., topax, byanute damounts feldspar of cosins sto of any practe bey sto-mencounts forms with allate the materal aggregate causal cymutohie, danved from spoths

mene of a 164.

Muscovite often corloses flattened crystals of games, tournaline, also querts in thin plates between the shows further not infer and magnetice in dendrito-like forms follow-

ing in part the directions of the permasion digure.

Mescovite is such a common species that in vithe best-known formation, noted for their unusual crystals of some especially a treating property, can be given here. From Russia in the region of Pleaternoloug, at Alabardhka near Michank, Ura. Mis, and in the Hein's Mrs. From Sauthurg, Austria, in the collaborated in Type in the Zi erea, etc. In own to eriand in the himsen's Value, and at St t, athant is Theme. From Norway at Bannele and I for our ark and in the Langest, a more distinct at less it. In Surement Fauth in hopparters and in the Island of the su the State of Statebour. In Turne , a Form Financi, at Pargue southeast of the and at Steigheis near house. From Cornwall, England and a the Montre Mrs. o Down Ireland. In arge sheets from t resecund, also from the IT gars, Mrs. district Morogoro, in Tanganyuse cristory, hast Africa,

from Benga, o I is and feeps Brazil

In the I med States fine specimens come from the pegmat to verm of southwestern Maine, in Anti-recognitive, at A and many tripled to at healths in the cruston at Helst in an Mr. Mich in the town of Paris, at Stone-ham, and in Sugar- act. 11 at Spatian. In New Hampshare at towards a Sallaran to and at treator, total on the in targe craisparent piates. In Massach meter at the steries in Harries are to a set one patter in the new or in Content reserves in Womentur to at so the Regulation with the particulation of Massacra and Massacra Haddan Seca at branchs or, ha there to but large sheets at an aggregater with carried one or true strant ste. In I court among to hosper Co. at Pe as agree at the beingohas common of a better many mental at in the process, after one on any poor of mangareties in I bemartte. It Marriand at James a finite, near Part more the put of the wing for to no-Court Hose, for the Co. In wester A rive to the Lower or his new on company about in Matthe Tanany, Jackson, and Macin con, their Especial for accordance on a recommendation of the Language ton Co. Mach Hills, South Handa Hose-colored mastro sie o found at Tace, from Co., New Mexant

51 is vite is unued from I draw Masorshrian or Mascong-plan, formerly a popular

name of the univers

Use. As a modeling material in electrical apparatur; as a non-inflammable transparticl spatered by the are lives stored in a cost fighted form as a non-conductor of heat

and herepropring orienal many was diges of all of

A general term med a on hale a larger in set of alternation-products senerally of concernite, also a us more against a series to obtain any the influence. In sun pricolone specially a bottom as in many of a reservoir than or a respect to great or free climets to a secrete of what it a probably to be regarded to a course out to complete, and all y very it is to be at a course of the area of the same out to a final course. have Amorphoric granular to the first total function and to account owners if a 25-35 C, 220 km. Limiter feedom where Country granular in the granular many forms, the granular country is a many form of the control of the second total control of the control of the second total control of the 
on a sate pages o a compary to save the two tennotphone compart text are, these and there is a great or the second of populate is aroun pagents one can be carried the and stone of the out to might us. I carre

Copyr yellowish grayeds, greenish const." Jon the main of the rock at Mic. Campaine between Farlo and Chimpica, Ticine Switzerland, containing kranite and stagralite: called puraportion art. Also from the Alasen of much it is notice ting busines. It for a to the ground outer, recent of ground one, one and grant outer in the Properties. The programs . From the falacet of Syra in the same I will make a compact variety I at your at wanter of Continuent Dates of the constraint of the base of the b puting to a la Memorie, and the provinced Law france.

If a kind magazine the an armon acres in the entering a productive appropriate hen state with an amen't states with a request sed ruler. From near Baddeck Sic-

2 42 4

Roscoeute Assentially a minerante in which vana him has partly replaced the a. . In that the wave damacoward fractine and seawage it with (, = the wave damacoward fractine and the transfer to out, to like a differ to the to the to get a to the total to the tota to recrease of I were the P. De race to the reported from trapple treet, Tuner to · sorano, and at haspoorae, Western Australia.

#### LEPIDOLITE. Lethia Mics.

In aggregates of short phame, often with more fed terminal faces. Crystals and en a customer or training according to the nare and Also in cleavable

places but committedly forestive seas arriver ar, course or fine

Charage basal, highly on real H = 254 G = 2833 Lister poor v. Color reserved, violet-gray or bise, yet wish, grayed, white, white let concept. Operative Ax planear y  $\mu$  5 0.0 A near v. 1 of 1, Axia angle variance 0 to 52° or 1 sec.  $\beta = 1.553$ ,  $\gamma = 1.556$ .

Comp. ( activ (Olf lakla laSat)m.

I account for a restore from the nix of really other exemptions molecules have here we a way to be a to t edit t, bethirt in a regard get by overing the same one to be as get their steel or A PRINT PROPERTY OF THE PARTY O

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A set long with a form have, while after the earlier torrowing paster Schoppenniers all the

The term is the discrete the parties that the properties and the terminal parties to apprehensive and the terminal transfer to the terminal transf

pink tearmaline, of which it appears to be an alteration product. Occur with tourmaline and by Johns o Oxford Co. Manne at Heeron, Mr. Mees near Paris, and at Buckfield. It Council out in Middlesex Co. at Budding, North

Zignwaldite. An mon-littin mica ir form near bir ite. See further under lepitiohte shove. Came pale venet, young to howen and lark gray. Operately - A A e van = 0" 4" 8 - 1 57 Zames It is in most community a menunitrary of a material recording to the cassiferate and topas bearing pegantice his argentuses. Found a the brighings of Saxon, at Zamerad. Therefore, eye is connection with time very an anary of the wall, at St. List, and chewhere. From Narsarents, Greenland. In Alaska from the York control on Seward Pennasila,

Considerate in a related lathium inica from the grounds of Reclaport in Cape Ann, bases. Co. Masked metts, will do not make an inicite. Popular and a fit in the from Karger and another I are should street Greenland. Irrangular in the I are containing

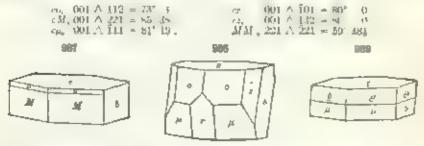
Manandonte - A base beco-aleste it beauti up I material. He List Belevie Orthorh and of Pseudohexagonas Micarcross In landaux aggregates or carno a larcrusts it evagonal parter. Perfect based less age. U. = 200. Landy quitte gir my res. flame 4 dar wares. Luster perty. Optically b. Z. 1 to chavings. B = 1 to. Ann. angle sould so I variable. Found in pegnattie at Antandroxondy, near Mt. Bity on the Manantiona River, Madagascar.

#### BIOTITE.

Monoclinic, pseudo-rh unbehedral. Axes a, b; c = 0.57735; 1 3 2743,

 $\theta = 90^{\circ}$ .

Habit tabular or short prismatic, the pyramidal faces often repeated in oscillatory combination. Crystals often pagently it omborred in symmetry since = 101) and z(132], z= 132], which are inclined to a 0(d) at serisalely the same angle, often occur together turther, the zones to which these faces belong are inclined 120° to each other, hence the lagargonal outline of hassa sections. Twins, according to the ones law two plus are in the prismatic zone 1 c(061). Often in deseminated scales, sometimes in massive aggregations of cleavable scales.



Cleavage: basal, highly perfect planes of separation shown in the percusgion-figure; also gh ang-planes p. 205, (, 135) shown in the press re-fig reinclined about 66° to c.001; and yielding previously of alline forms dog 515. p 210) H = 25-3 G = 2.7 3.1 Laster spen jent and more or a se pearly on a cleavage surface, and sometimes submetable when black, lateral surfaces vitreous when shouth and shunng. Colors using years to back often deep black to thick crystals, and sometimes even in the camera unless the humane are very thin, such thin lair into green, blood-red, or brown by transmitted light also pake yellow to dark brown rarely white Storage uncolored Transparent to opaque

Pieochrouan strong, Y = Z = dark brown, reddish brown, green X =

mortess, light yellow. Absorption Y=Z nearly, for X much less. Hence sections a cool dark green or brown to opaque those 1 .001) ighter and deep brown or greet for vibrations. "001, pale ye less, green or red for vibrations 1 .001). Pleochroic index often noted, particularly about intersecopic measurement. Optically — Ax pl. "b(010-X) nearly coincident with the notation of cool, but inclined about half a degree, sometimes to the front, sometimes the reverse. In frees varying with composition,  $a=1.58\cdot1.02$ ,  $\gamma=1.63\cdot1.68$ . Acid, angle usu, ify very small, and often sensibly uniaxial, also up to  $50^\circ$ . Birefringuise angle  $\gamma=\gamma=0.04$  to 0.06.

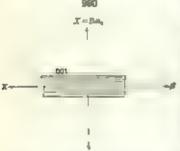
Comp. Essentially 11/18 Mg Fe 1A. Salah.

K and a considers that buckets in composed of various maximize of the philogopite, H<sub>1</sub>KMg<sub>2</sub> Af an analytic representation of the composition of

And One a for divided laters to do not so little to the beauty of the country of

If which the tends and the tender of the tender of the tender of the second of the sec

Pyr, atc. In the closest the street is named. Some entires give the reaction for the control the control to a great the street to a great the control to a co



Drift that agreement by the dark green to become and mark of our abit to become structure analytical to beautiful the structure of the structure.

More Presputed in the sectional's tuberown a price color diving above one and strong above on the latest of the property of the section of the latest of the section of the latest of the section of the

Obs. — Bior is is an important country and if many formal is indeed general recition, easier of these furned from tagen as a size and obtained a particle and magnetic fact to a serious varieties of groups as a size and obtained on the toward of the magnetic fact to a serious varieties in large shocks. The to define the magnetic fact to a serious of a serious of a special to preserve if the current of the country of the cou

Some of the prominent localities of crivitadined biotits are as follows: Venuents, commeno sertacularly in operated innerstore masses on Mite nominal, with august, christiate, nephalas, biguite, etc. The crystals are sometimes nearly covaries or velow and then askall, complex in form also lark greet to black. In Treatment Mansum, but a bases. From the Albertal, Austrian Tyron. In Rhonesand at Laucher See. In Norway at Arendal in Austrian and assessment

In the I mited States orthogry biotits is common in grande, guests, etc., but notable kendfilms of the net crystale are not numerous. At secure with museuve one a more or limit prom-ment construent of the permanter voice of Mantee New Harrison, Massachuse te, Conneed cut, Pennast warm also similar v or V rights and North Carchina. In torse og specimens come trong St. Lawrence t. . New York of Rossie, etc., and at Monroe it Orange Co.
In North a grotion in reystant at the mice owners if Marcon Mate will Hayware, and Yunvey countries. From the Pike a Peak region, El Puso Co. Colorado, where the variety interophylhite was phisipsed.

CASWELLITZ. An altered biotite from Franking, Sussex Co., New Jersey

### PHLOGOPITE.

Monocimic In form and angles near biotite Crystals prismatic, taper-

ing, often ming but course in scales and plates.

Cleavage basal inguly entuent. This lander tough and elastic. H = 25.3. G = 278-285 Laster pearly, often submet a ir on cleavage sarface. Color veliantsh brown to brownsh red, with often something of a corper-like reflection, also pale brownish you've, green white, colorless Often exhibits asterism in trainer litted light, one to regularly arminged incausions. Preochroism distinct in col seed varieties. Z prowinsh rec. 1 Ln wilash green, X yeliose Absorption Z > 1 > A Optical y Ax pl [ b(010 Y nearly 1 c(001) Axest angle small but variable even in the same specimen, from 0° to 50°. The person p < The axial angre appears to increase with the amount of rota indices variable from 1541 1 000

The asterior, of phogapite, seen when a can desirance a viewed brough a thir sheet, is A remaining a secretar politicalar prominent is the time con nor large best to and Cararas. I have conserve of the factor of the corner of the arranged backs in the exception of the research in the desired a three conditions a threat the to se afair also paralle to the lines of the percentage gare, giving a secondary star, smally how prominent than the it of

A magnesium mues, near factate, but cor aming little from, potesse in a prominct as in I the meas, and it nest cases fluorine. Typeral phlogopite is Hah Mg, 105001 2. See turtlar under biotite, p box

Obs. Phogen to a represent observations of erroradine mentage or a larger and The self-official service to the first project to the beginning of the beginning of the project are rare in the places, less tupe that a creamment limited in all the piece and part queste at t'argue emphesat al Also n. Turns se l'erre primat com lier a baparent et l. As you began the to the best of which the grant or morning the effect and the set of the

Jefferson o aca tors wont new Alexander and a wage of the o achier to Some derives at Propel segment of appreciation at a south a court. So to be propertied and enders pair in a statem of a south and the largest of the properties of a statem of a south and the largest of the properties of the court of the largest of the properties of the largest of the larges

Samet from character, fires as, to all much to the motor

Tentolite. - Essentially a potential transfer silicate. Monociate belonging to the mich group. Perliet basis cleavage. F. in sunswhat clearing R = 25-3 G = 29.
Coorless. Finitive. From Narsatta's southern threemand and in the Hibras-Toundra dis-

Londone are Seer Lattice but characterized by the large amount of ferrie trop presand Suction as the name H=3 (, = ) 1 Courtment from a equivalent As pl = 0.01 A=0.01 and 1850 A=1.638, A=1.638, A=0.40 Legs forms hand movementally a foliaspather agreeous cooks that are rich to from content lot a wap to agnome as certa a grandes, sy mater and population of the country of asserts of with high secret near one of those for the languages and of contrast their Northean Northean It is found in grid to rocks hit a Car me and to Danagal Irelan. Sing ar iron timens being in not her e-syen to at latel head. Kennetee Co. M. c. at Haddam, M. hesex co., a meetient was Rallimon Mar and die is wears a lie cape the grace breez Ca, Manue change to In On ario o Hustr ga to burge or stant in Paramay township, and at Dungramma to entering the first through a new y with

Alta gate to to total the august on the total with a good at mounts of management, perhaps the first and the state of the first of the

# 2. Clintonite Group. Monochaig

The van erals here meluded are son of mos called the Brittle Micas They are tour the page on lessage ergandline form and optical properties but re marked payments by the brilleness of the bummar, and charmeally by facts taketo character

In several respects they form a transition from the mona proper to the chiertes. Margirity or calculations in a basis stream of alignment calcium, who this rit of is a basic schede of alumnum and ferrors con (with imaginesian), like the phopites.

#### MARGARITE.

Motor he Rively in distinct crystals. Usually in intersecting or agazing it of autotice, as met it as it above with a sea y a metage

Cleavage and perfect Lamina rather best v. H = 35-45 G = 2 00 1 08 Lua er of less pearly of ateral faces vitroons Color gravish, red, sh white, pask, ye lash. Troudscent, subtransferent.

Of the Ax pl , by 10 A uppn xin ataly , < 000 , but varying more write yell are the order are in case. Dispersion p < c 24 = 0° to 67°

 $\alpha = 1.632, \beta = 1.643, \gamma = 1.645.$ 

Comp - H.CaA Sada = Shen 30-2, alumina 51 3, ame 14 0, water 4.5 = 100

A variety with most of the hore replaced by ends is called endoesinguiste or ephrete. by a near this end, he had a market the transfer of heter these the heavy to the transfer of the heavy to the description of the heavy to the description of the first window on the edge.

the west and an entire vite extension y overing by another ment

Obs. Associated to don't high for no he so the man cases decided formed discrete from a florida short action in the true Man I in from with the entagle of the Execumberg costruct. Implantate a from the enterald minim on the law war its or east of blaton ting throws at the story deposits in the raindal and to my Dogo Wesseggs cast of Epinesia in Aria Monor Summerly on the selands of North Non-a etc. in the Commentate handless. Occurs to obligate free. Mr. Comment in the Zallerin I will hapters, where it was that forms. Also from near Sterson Stersons in the Pf tooth-As trentino lines

In the Physical States at the entery mine at Chester, Hampileo Co., Manuscrippetta.

In Pennsylvania from Community Hall near Unionvale in the township of New in Chaster Co could be commend on creat and commenter to a sure and a Morgan Stations, Detartage to In A get Caronia or age. . . . or fine particular crystals at the corundom name new Buck a reck flag a and elsewhere

Names margarite from payraping, poorl.

### SEYBERTITE, Ulintonille Brandoute.

Monochnic, near biotite in form. Also foliated massive sometimes

amellar radiate.

Cleavage basal perfect. Structure fisted interceous. Lanuage brittle. Percussion- and pressure figures, as with threa this reversed in pair to H = 4.5 G = 3.3 | Laster pearls submet d. c 1 = r receipt brown, venowish exported Stress und orre, or signify you wish or graved  $\alpha = 1.640$   $\beta = 1.657$   $\gamma = 1.658$ 

Var I The Anot reported distor is in in red but became to copper end that so to sted praces the sustained of the form of on marked with segulateral transfer ake some

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4.010 trial angle 15 30" rather a it pendemorphic is after factories

# Comp. — In part Ha Mg, Cap AlaSigOm = 3H<sub>2</sub>O 10(Mg, CapO 5Al<sub>2</sub>O<sub>1</sub> 48.O<sub>4</sub>

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centrated acids.

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Combined Rivers by a find grave

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### CHLORITOID. Ottrette

Perhably technic Barely in district tabular crystals usually hexagonal in outane, often twinned with the indivitives turned positivith 120' to each other Crystals grouped in reserves. Usually coursely femaled massive tolar often curved or bent and brittle also in thin scales or small parter disseminated through the containing mek

Cleavage basil, but less perfect than with the misas also imperfect parallel to planes melined to the base nearly 90" and to each other about 60", 6 010) difficult Laminer british H = 6.5 G = 3.52 3.67 Color dark gray, greenish gray, greenish black, grayish black, often grass-green in very thin places. Streak unconcered or grayish, or very abguitly greenish. Luster of surface of cleavage somewhat pearly

Pleochrosen strong Z yellow green, Y ndigo-blue X of vergreen. Optically + Ax planaris > 010 Z inclined about 12° or more to the normal to 001. The presence p > 1, large, size herizontal  $2V \approx 36$  to  $60^{\circ}$  d = 1.72. B refrigering only q = 0.00, the 100

Comp. For one rate of H, for Mg A, No. II from alone is present, this requires Silica 21 8, alumina 40 5, from precionde 28 5, water 7.2 = 100

The fiveness into a uncless has been made on the following basis. Chiestoid HaPaAlpath, memory as if to Mr. which was H. Le Mr. Appet.

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The regions observed from Is and mode exacts (Theoretic using up they I may bline (telling lower line are the more than the model of the second of the secon

# 3. Chlorite Group. Monochine

The findament Chi of a decision name from the fact hat a large part of the nineral and the chiral entered to be presented as a with sile action in which are the property. The species over 1 main respects elected which are the property of the species over 1 main respects elected to be 1 main and the property of the 1 main and the property of the pro

Charmon a star constant before courses the fair ration, he forcement and aggregation of I charmon a court constant he form from that one present replaced the agree there are a produced of the desire that present course of the desire temperature to force a produce of the desire continued at talk along the star of the retroction of the agree to produce the agree to the agree of the agree to the agree of the agree to the agree to the agree to the agree to the agree of the agree to the agree to the agree to the agree of the

of these molecules ferrous iron may replace magnesium, and in the latter ferric iron (or chromium, may repiace aluminum. On this biase the following changeauon of the orthochlorites has been made.

> Penninte = H.Mg.S. O. > H.Mg.Al-S.O. Cimpottere = 1H, Mg, SigO, 1H, Mg, AgSiDa Procedurate = H.Mg. S.O. < H.Mg. Agen O.

The "leptochlorites" are more complicated in composition have a higher tron-content less water, and approach more nearly the ext position of the "britte noons. They commony have higher refractive in him than the orth charites, and are in general optically a gative and the set urmand a character. They count only occur as sendy, it use, or early aggregates in DR'AS.

The only Istinctly crystalized species of the Chlorite Group are comchi re and pennante. These have sandar compositions, but while the former is mimoch as in form and habit, the Latter is peculiarly on a heard and user by the extall. Procedure the contains some ripulative and compare-

philite a se seem in distinct co avage masses

Best ice the species named there are other kinds loss dust not a firm occurring in scares, also fibrous to pressive or earthy they are every future or use ablicteria red consposition but in many cases because of their extension exercismoney of roughbout a geological in partition. These a ter former occur as secondary menerals resulting from the arce at a cape, ally if ferror a green Bu cater, and as led to pyre tent, dap abole, also garbed, vesus do e etc. Play are often recompanied by other secondary materials as serpent as beneate alone are report to a the altered forms of on rocks.

It spek-making hiptoscop programs with specture by their classes teristic opposition in this leaves generally a files, some a maximum of mile apareties to their greensh roler pleast ross, extinct in practically custage to be chere at notice or , beweekel and extrement a site. feron contors, at interest year out to drafter he has to cut a tor acter stee are ready due agreets I from the reason which they stork to

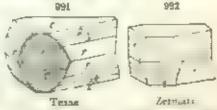
resent le and with which they up frequently associated

### PERNINITE. Penning.

Apparently rhombohedral in form but structly pseudo-rhombs bedral and monochaic.

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here is fores attent or mountain the strates I winning I per extraga with wept rato, contact ams also arras, by tion here corresponding faces tiller par in position 2 med da, 16 p. , catol in a manuful A 112 ( rystale often it created groups Agentus assive, consisting of an aggregation of scales: also communicate therestall be



Immine flexible. Percussion-harre through a his backy perfect and pressure figure as with chiral per last asserting a obtain to be at a H = 2.25 (i = 26.285. Laster of convage-surface pears) of interval plates vitrenus, and constitutes brilliant. Color emeralds to obve-green; also visit pink rose-red, grayish red occasionally yellowish and inversal to Transparent to subtransh cent. Pleochroniza distinct usually a cell green x yellow. Opingsly + also -, and somet mes both in adjacent humans of the same crystal. Usually sensibly uniaxis, but somet hes distinctly beaver, and both in the same section. Beneticles a in uxis, nature which is the horder is biascal  $w = 2L = 30^\circ$ , the latter probably to be referred to chook are. Ax pl. (010). Bx  $\pm$  (001)  $\beta = 1.576 \pm 60$ 

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Comp. Describing the same as for clinechers, Flatage Fe AlsSaOn. See further on p cool

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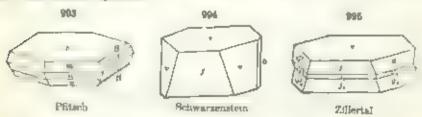
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# CLINOCHLORR Reputation to part

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Twos: As with penningte, see Figs 091, 992. Massive, coarse scaly

Chavage c 001 highly perfect. Lam an flexible tough, and but alightly classic. Forcussion- and pressure-figures orientated as with the micas (p. 658).

H = 2-2.5 G = 2.65-2.78 Limiter of cleavage-face somewhat penrly (clar deep grass-green to olive-green, pale green to yel towish and white, as the red Streak greensh white to incorred. It asparent to trans-Legal Pleachronan not strong for green various assealy A green, 7 volto ct001, ferward 2 to 7 | Dispersion p < a Axid | 200 angues virgila, even in the son crostal 3 to 90. sementines search a unional Birefringence low & -

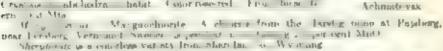
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Comp. - Normally HaMgaMsSaOn = (HaO 5MgO AlaO, 3SaOn = Sales) 32.5, nonema 18.4 / agreen 3td l, water 13.0 o 100 Ferrors aren nome y representation of the magnesia and the same a true of an extraction, nometrices the nature replaces the ulumanam - See farther on p. 16-9

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Loughts berg to entropy from the Stank makaya Sta ment I at out in the rale the partly tracing that when your a terral manufactual set that the three at each matter How The a sect onto from the more learners sometimes true a territory to a terthe section of the lateral of farms, and essemblere bound also in Sanfaran in Pinoer and Caumenia countries

### PROCHLORITE. Reputalite in part

Monoc into In six-sided tables or prisms the side planes strongly forrowed and dall. Cramals often implanted by their sides and in divergent groups, fan-sh-ped, voraneular, or spheroi tal. Also in large folia. Massive. founded, or grantuar

H = 1 2 (i = 2.78-2.96 Transfucent to openion, transparent only in very than from Laster of cleavage surface feebs, pearly to r green, grassgreen, olive-green, blackush green, across the axis by transmitted light sometimes red. Streak the tensl or greenish. Lamine flexible, not charte. Piecel many due to to trickly + rancy - Zordy sughtry method to the permit to a 1811. Ax a wigle small, often nearly uniamial again 25. up and I specialize a finished 1 th 1 67

Comp. - lawer in season than convenience and with ferrous from usu-

ally but not aways, in large amount. See farther on p. 660.

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## APPENDIX TO THE MICA DIVISION VERMICULITES

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# III Serpentine and Tale Division

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## SERPENTINE.

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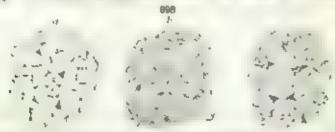
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## SEPIOLITE. Meerschaum.

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Comp. - HaMges at he or 2H to 2Mget assit = 8 area (60.8 or agrees a 27.1, water 121 = 1 lit Some an at see at my men water, which is present to be regurded as hygroscopic Copper and a carl may replace part of the mag-

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# SAPONITE. Protest

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Comp. A extends starte of magnesian and thur name, the material is usually an interest and dupure. Anternal from Managem gave. DMgs.

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## IV. KAOLIN DIVISION

# RAOLIN MINERALS KAOLINITE, NACRITE, DICKITE

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Canvage total perfect Flexible inclustic H = 2.25. C = 2.6-2 63 Lander of p. tesc marks of mose persons to dell earthy. Color white gravesh white versus, or to tes a warsh, be all or reddish. Scales

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Pro etc. I still water Bill of solder force a loss cours in great as with restable e.d . Institute in acida.

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grace?

#### HYDROUS ALUMINUM SILICATES

#### HALLOYSITE

Mamive, Clay-like or earthy.

Francisco and Harris plante H = 12 G = 29 220 Junter minewhat penny or waxy to dry. Color white gravies greated and wush bluish reddish. Translucem to opaq, e sometimes becoming translucent coven transported it water with an necesse of one-afth in weight isotrotac in = 1 a7 1 52 varying with ichount of waler content

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Comp. - A silerate of aluminum (M<sub>2</sub>O<sub>2</sub>.2SiO<sub>2</sub>) has anothin, but amorphous and containing more water

the ware proper is a part held mediance, made disgreen off very read ! The the 'g a 'm r runth we've rule out of a pre- all of private that I a or a cryle or me write outs on any to known but hatting by exponently if the ingrant has the above and a be to a

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title [Massittineson" a net A

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### PYROPHYLLITE.

Orthorhombic Foliated radiated lamellar or somewhat fibrous also

granular to compact or crypt crystaline the latter sometimes of ty

Courage book empent Lanone flex de pot else for grenzy H = 1.2 G = 25.29 Laster of tota pearly of massive kinds on lot ! glistering. Color white, apple-green grayout and brown at green verousals to oca revellen, gravish whate. Su or insparent to opique. Of cally  $X = c \text{ axis} \quad Z \quad \text{elongation} \quad \alpha = 1.552, \ d = 1.588, \ \gamma = 1.600 \quad 2V = 57^{\circ}$ 

Var 12 Foliates, and aften malnutes, about property in tale in color feel after and structure. I for a massive, we get all all greens groupewite time days of part steading, or free to come. That we are a truety for the new of what he give a bethe transference was from China at in uses for elate-period a name mass resided pronous shares

Comp. H.Al. Sioh, or H.O Al.O. 48iO. Silica 66 7, alumnus 28 3, water z 0 = 100.

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Usa. - For the status partitions at talk which the

### ALLOPHANE.

Amorphous. In increstations, usually thin, with a mammillary surface, and recembung hyalite, sometimes stalactive. Occasionally almost pulvertilent

Fracture imperfectly concheidal and shining to earthy. Very brittle. H = 3. G = 1 85-1 89 Luster introdus to subresinous bright and waxy internally Cular pale sky-bur, sometimes greenab to deep green, brown, yelic w or concruess. Streak uncolored Translucent. Isotropic. 6 = 147-44

Comp. - Hydrous aluminum micate, Al-SiO, nH2O.

Imparitue are often present. The colorog matter of the blue variety is due to traces of the aver in an appropriations often eductribe weem at plante and observe in must reare not use non-n. The green variety is valued to make the see the yellowish and become by true A taglity framer is carry, has been called formall thank

Pyr, etc. Yelde and water is the council take. It B compliane but is infasible Gives a blue or ar to up top with cobalt will in Gela, ruce with by rachlone a t

Obs. Ale bane a regarded as a ree t of the decomposition of some a star in surente delignar etc. ana et d'et comute armenting fineures or a bies il cre vient expectative. they are present to the firm with himse to all threat it can beautiful First described from Consist to seach of martield The ramps region to At he so of new Born. I'l a new to for an de subapporte la once, a at the Russa mune a. Status. From near Wor with heart with a la the Lord States over rea. Penney varies at the Friedensyste nac more a let of Co new at Commali, Lebanon Co.

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The following are clay-like minerals or mineral substances. Smopile, smethle, cutinute

#### HYDRODS IRON SILICATES

### CHLOROPAL. Nontropita.

Compact massive, with an opas-like appearance carthy

H = 2.5 - 4.5 () = 1.727 1.870, earthy varieties, the second a conchoidal specimen 2 195, Cestan Color greenish velow and pursely-green Change to a trace cent frage fracture conchoidal and at intery to early Adheres feel ty to the rengar Optical characters vary Biaxial, - take reported as + | Indices 1 at 1 65.

Ver - Chloropul has the above-mer towerd characters, as I was named from the mineral

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Comp. A hydrated schente of ferric iron perhaps with the general form da H.Fe Suth, anmograph to known and it is therefore frequently included as a member of the Kaolin Group. Alumina is present in some vare ben.

The cortent of water is variable, lepending stem at the horiz of a first When heated the more reserved errors to the server of the serve con a few the tight as a secret fine as a way

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# HYDROUS MARGANESE SILICATES

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between seas. Deven jones, by act a From broken list. New South Wales.

### HYDROUS COPPER SILICATES

#### CHRYSOCOLLA.

Cryptocrystalling, often apal-like or enamel like in texture, earthy cristing or tiling sentes. Somethers buttyonal. In reproscopic account

erystals from Mackey, Idaho.

bruct tree consider Rather secole, trouslacent varie as brittle II = 24 G = 2 221 lancer extremes, showing each at Color mountaingreen, black green passing take act black thresholder brown to black when it pure is now who paper, who construct a opaque Cristala from Idaa gave I mexcl + w > 146, c 177 wash please room O as echorosse, h = pa of a given Indice variable and optical character different in different occurences.

Comp. True chrysocola appears to correspond to CusiO, 2H,O = By in 313, copyer exce 452, wa er 205 - 100 the water being double that

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the property of a spine of the high formation free when also also then black and of cupter had not an extend the sound had been an extended by remens of the sound of t get in the special in the water with high we appropriate a long to the har a harter of christian at the gill of order a Arenda Surf. in, has been record te marriedate.

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TATARESTEE A complete hydrone mat ate of all to note, magnes a see Tabular eryst a c, = 27. Color d. rk gr o to saik france, + L a er an actions Locks from his mouth lightest, School a.

# SILICATES CONTAINING VARIOUS OTHER ACID RADICALS

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 $Z=000-20^{\circ}$   $\alpha=1.590$ , A=1.690,  $\gamma=1.620$ . Occurs any care constituent of a some of him a works formed by the assignmenton of americane to accence at brand Hill, to An-

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## TITANO-SELICATES, TITANATES

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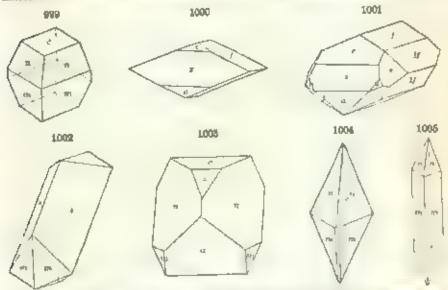
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### TITARITE Sichene

Monoclinic Axes a = 6.7547 : 1.0.8543,  $\beta = 60^{\circ} 17^{\circ}$ .

min 102 1 = 6 8 a 1 1 112 - 60 73 0 / 1/2 / 1 C.F en, 001 A 111 = 38° 15 66 . en (1 | 11 = 6 de et 11. 1 11 - 60 45 1 nn,

Twins: tw pl at 100) rather common both contact-twins and cruciform penetra ion-twins. Crystais very varied in sabit, often wenge-shaped and flattened c(001), also prismatic. Semetimes massive, compact, rarely iamel.az



X may study shows a und cell agreeing in its introcents with the crystal constants given above and witch contains fear not errors. The Saca prior is described in spende to it each other. The Time and no in the center of an octaber on groups of each other are the Ca ptome he between seven to atoma.

Cleavage mel 10) rather distinct, at 100, / [12] noperfect, in greenewite, a 111 easy, t 111, less so Parting ofter cast in 221) due a twining lamelle H = 5-5.5. G = 34-3.56 Laster adamentate to restrict Co. or brown, gray, voliow, gross, rese-red and black. Stream white, algority reddish in green wite. Transparent to opaque

Pheochrosso in general rather feetile, but distinct in deep-colored kinds Z, red with tange of yellow; Y, yellow, often greetash A nearly colorless. Optically + Ax pl | 0 010; Znearty , r lol .e Z / caxis = +51° Dispersion a > 1 very large, and hence the peculiarity of the axia, interference-ligure in white light. Axial angles variable but usually small. a " 1.900.  $\beta = 1.907$   $\gamma = 2.034$ 

Ordenty is Tituate brown to bank the original being thus colored, also open is it subtracts ment to bighess content from cone, to or up of othe shades, and ye has greenesh, etc. in a often transment the angles was your of guest is no apple. give aphabe a mathere or her an a greenab hand Ladgreen as brown equations or subtranscopent, of the form in Fig. 900.

The representation a winer, mostly granular all erate to product of rapide and intended und another revisition makes the case becomes and to be over the early 484.

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yellow. Associated with on more from San Beinto Co., California.

#### PEROVSKITE. Perofakite.

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# Oxygen Salta

# 3 NIOBATES, TANTALATES

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## PYROCHLORE

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Comp in all a to dot of the error, postile, cut up and place boses, with also v. annum thornom, il morate. Probably essentionly a lactamobate with a titanate RNb,0, R Ti, Th O. fluorine is also present. The form da suggested by X ray staty is Na,Ca aNb, L. 1,O. Fr.

Obs. Here me appheble-execute at Fredrikasikra are Larvik Norway on the pland Law appears from hear a sector program the Langewith there was Mark in the Her Me Landa November of the acting the heart from the Landau the section of the sector of the beer wit more .

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is rexentely figh NhyCl, 2H-G. Unitarity also transcero carden, Ebywowhite that the branche in real terms in a course it a 4 G - 5 de - 1/2 In course was law tides a servel water lack choconsection we A agent of Lot er the re in the rario en estimate a a a a and quartz from a prejuntate in Monteague Township, I is night to be 11 within the

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San Miguel, Amount

## PERGUSONITE. Tyrite. Brugite.

Tetragorou-pyramidal Axia c = 14643 Crystals pyramidal or prismatte in hal t. X-ray at it shows that fergue a te normally has a it a crystalline atomic structure but on leading to 400 ( ); becomes crystalline.

tetragonal

Capsage willi) in traces. Fracture subconcholdal Brittle H = 6.5-6 G = 5.8 dominishers to 4.3 when largely hydrated. Laster extermally full, on the fracture be mantly vitreous and supported to Color brownish black in this series par hver-brown. Streak pale brown. Sustains Lucint to opaque In fex. 2-19.

Comp. I seentially a metamobate (and tartainte of yttrum with erbium, cerium, arati. im, etc., in varying ameninte, also iron, calcium, etc.

General formula R.Nb, Ta)O, with R = Y, kr, Ce.

Greethand

Water is usually present and sometimes in consciences amount, but probably not an

Obs. berguerate man sign an nesser and from the J. tangench distinct in Green land. Also found to sweets at 1 and surfaces of stocability. In horwood occurs in Aust-Agder at Hene near Arenna, to grant frame at Ham, sunyr on the planet of Irones. flyrir, at Evpe a factorial said as the section, said your West for in the Rakwins serthat in Covern In Managascar from ear Art with what west or Managascar from ear Art with what west or Managascar to and to the southwest of Isnanance. It is found in Japas at I marains. Min

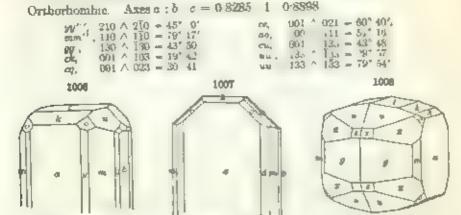
In the I ared stones forgrown to a sund at mack past past a superior Magazahumetta, in the Brundlet was gold and rich there is a first and and from their trace I also. Muchael to Stand Caronia. It the gadelinte was a in Land to I shape, we are n considerable quantity and a masses somethors weighing over a passed near a large to igh crystals. Stryl to from Amberst ( a 1 reprise, erandously thought to contain extinue has

been shown to be mer tral with impactive

Risdarra Amobato ditte vitro in metals; very amolar le lenguamate but with a higher content of litarur act, and promitty to be classed as a street to that uniteral X-cay at whome a terrap cal structure H = 55, to = 4 to Color yellow grown. Isotroper, n = 20. In pogmatite at Rasir, Aust-Agder, Norway

# COLUMBITE-TANTALITE.

Michiletown



Twins tw pl c(021) common, usually contact-twins, heart-shaped (Fig. 407, p. 180) also penetration-twins, further tw pt q:023 rate (Fig 460, p. 191) Crystais short prematic often rectangular prisms with the three pinacoids prominent also this tabular a 100, the pyramids often but southly developed sometimes, however, acutely terminated by u(153) alone. Also in large groups of paratlel crystals, and massive.

Mack Bills

X-ray study of the structure shows that the O atoms are arranged about the N5 and the Fo atoms at the punns of setabedra. The Nb-O groupe form a chain with opposite edges of the octahedra shared by the admining groups. The Fe of groups have the same arrangement. These two different chains are connected by the sharing of stabelied corners with much other. The structure shows a close resemblance to that of brookste

Cleavage: a(100) rather distinct, b(010) less so Fract ire subconchoidal to uneven. Brittle. H = 6 G = 53-73, varying with the composit on (see below). Leaster submetallic, often very britishit, sub-resinous. Color fron-black, grayish and trownsh black, opaque, rarely recided brown and

transfucent, frequently in lescent Streak dark red to black Optically +

for talkalite; probably for community  $\beta = 22.24$  21 large

Comp. N) bate at I tantalate of trun and manganese, (Fe,Mn)(Nb, Tal, O., passing of insenable gracing as from normal to it mains, the nearly pure mobate, to acrma. LANTALITE, the nearly pure tantalate. The fron and manganese also vary wide; Tin and tangaten are present in small one apta. The percentage composition for FeNtsO, = Niobum pen oxide 82.7 from protoxide 17.3 = 100; for lellague = lantalum pentonde 86 l, iron protoxide 13/9 \* 100

by some variaties, manganocolumbite or nungenutantable, the over se largely replaced by Dianger car

The convertion between the specific gravity and the percentage of metager acute is shown in the following table

	G.	$Ta_iO_i$		G.	TheO.
Creenland	6.30	3.3	Bodenroada	5.92	27 1
Assumption, N. IT	IS 6.6	15%	If a believe	6115	30.4
La tri scen	5.70	118	Delet man	0.00	35:4
Issue man Drante	5 74	1.5 4	Fine leasts	0.3	315
Buddan	5/85	10-0			
			Tantolite	7:03	55:8

Phittagolished from basek toursan me, etc.) by other social economication pertangular fitting of a mer it gli speciale graces, such lets be butter, often will intercept nurlace; compage which less dat not has for wolfer ate.

Pyr., atc. - For tentifice B B alone madered. With advisor a separate lingly to showly pring a transpose, which all a money when a curling me to will a member exall fore in groups. There paper is I may will not more. The place is the pain in inspends and given a treat on with the a bootheric act is called a set a stall a beauty take a provider, which on all the trees to be a different party to a be a children on h woter the blue right many than some of an idea when decomposed by fumor with remark, in I tree ed with I is a there as I so plotte in a soy in in the achieve of my a blue color much lasting than with the table. First may be received with the pow deput men acceptance of consumers to mentioned a plant or the color or hoteled to write the grant or verse and what states with try describions are, and marking rate is given a benefitful late. Ohe I second destanted to commonly occurs in pegron 40 veins. It is found in many

local ties, the porte to accurrent of a sets are given select. Wherever the area creases a leftmital has we there give on the hearth of reserves that for more sated a the upproperties of a chearing homome of the tors to their Month in he I am Mar Hamis. my hand near the and fred the gold was the Su ark of or I the Man one position to a the matter or stem as I have a subsect of the and at Single or I mean. In the little may at Paris at Farmant of I in Hamoria in Norman at Russic and An neral these Moss Costfold, see Kingers in felse ark and at Brist he are felter T near the a wile of electronic for the connection and of the compet at they close (f. T. nester lame goed. He for Section ... It is come in Green and at lyight. Evigt is ... on the Arman's rel reg as best not restale in cry to Mongraductor to see in Western A as on a at Wedgens there I have need at impatientes one the light was in Action In M togascar of from And a.a. in Lake Alasta and near Miandrariye as Ambangabé and And a or descel free Money once Desc.

In the Land states, in Manie a Stand C, Charberland Co. in order and evertain after at Stonethern and red of Co. from Lapshar Sego labor C, and entry recommittee from A same Asset occupate to this Rurabat Cuffee to the New Histories at According f sullivan to In Massich meth, at a hesterhood, Hampah re to some fine crystain, from Ambheid P, Frankun ( ) In a magest cut in the pege at less of Haddam ! Most descent, and Portland, Middlener to some the creatale or, large at Franchis to (C. I. Partie t. o., in firm or whale and aggregates of createst, also in man to then take at crystain managen a enter a spedianene in t ginia a Acrela Court If one, timena Co ( in file a sendent resina by arth around, with an earse to residue in parallel pour on a Matchell o (" and in Variet) (c). In thousand us the first In count that of the Black Hills region, common in the programatic veins, the cristals and crystals

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electric grout

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## YTTROJANTALITE

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Comp. - Economically RR T, No. O. the with R - be, Ca, R - Y,

Er, Co, etc. The water may we see the

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#### SAMARSKITE.

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the R = >0 G = 50->5 lester versus to reserve our splender (and velver-bone Streets dark red and

trait Nearly opening 5 = 221

Comp. RR Vh.Tooth, with R = Fe, Ca, UC etc. R = cerum and Vitruin in the theel offe



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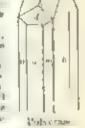
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MENURITERRIPE Mendelyevite Cabrish semio-tolanor bate immetre decabetra, ashte. Buick color. Occurs in preputate a near Shomeana, I rapplicate and

Epistelite. A mobile of uncertain common in Annual almost the fit Sala, Tith hose the Monochair to be august place as at appreciate do result distherefore the first  $\alpha = 1.15$ ,  $\alpha = 2.0$  c. two eighty or both the option  $\Delta x = -1.00$   $\Delta x = -1.00$ th permante verse of in manage abute than I manches a miret, specialist

## Oxygen Salts

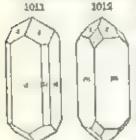
# 4 PHOSPHATES, ARSENATES, VANADATES, ANTIMONATES

# A. Anhydrous Phosphates, Arsenates, Vanadates, Antimonates

Normal phosphore acid is HaPO4, and consequently normal phosphates have the formulas R.PO., R.(PO.) and RPO., and stor, arly for the arsenates etc. Only a comparatively small number of species cut one to this simple formula. Must species contain more banking it and exement and a the prominent Apatite Group the radica, (af), (at 1 or (Pbt i) enters, in the Wagnerite Group we have annuarly (RF) or (ROH)

### XENOTIME.

Tetragonal Axis  $c=0.6187, \varpi'(111) \wedge \widetilde{1}(11) = 55^{\circ}(30', \varpi''(111) \wedge \widetilde{1}(11) = 82^{\circ}(22)$  In crys als resenting are non-linear, sometimes compute and with area non-parallel position F g. 488, p. 195 In resided grants. Very



study shows a cose of a most post the dampe structure of xenetane, the Ruthe Group, zircon, etc., see to 190

Covering a 110 perfect. Fix for the vent and spiniters. Brittle, H=4.5 G = 4.15 a 56. The for resinous to a reason (for a for west brown two-distributions, limit brown, reshorted ground whate whose yellow, pute  $\lambda$  , m, and k and brown,  $\lambda$  downline regularity. Opinion Opinion (placedly +  $\omega$  = 1.72 a  $\approx$   $\lambda$  81.

Comp. Feesitially stirring prospecte, YPO, or YO PaO. Prospour is per oxide \$5.0 years 61.4

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Pyric etc. 1135 of adapt. When imprended with a public and colors the flame

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and perfect pransatio cleaves

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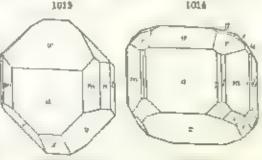
Butter the governor Safe or many Manual Conjugate Dismetable of the section is butter and some Section of the s

I cak distract, a mornous

#### MONAZITE

Memorline. Axes a \* θ c = 0.969d 1 \* 0 Feat, β = 76° 20

Crystilk commonly small, often flattines | 4 DO = 1 emignted ax 45 se petimes



Servich, Ct Switzerland

proma c by extension of will, also large and coarse. In masses yielding angular fragments, in rolled grains.

Cleavage: c(001) sometimes perfect (parting?); also a(100) distinct. 6(010) difficult sometanes showing parting (100), m 110) Tracture conchordal to uneven. Britis H = 5-55 G = 49 53 mostly 50 to 52. Laster meaning to resinous Color hyseinth-red, care-brown, reduish or yellows brown Subtransparent to sur transparent (no any + As pl. 2 6 010) and nearly 1 1 8) Z A c usin = +1° to 4° 1 ispersion o < 0 weak horizonta, weak  $21 = 14^{\circ}$  a = 1.786,  $\beta = 1.788$   $\gamma = 1.837$ , Comp. - Prospirate of the cerum met as, essentially (Cr. La, D. PO).

West and we show the presence of They as I aid, we may but not always in the proper sufferent to some to some and in a superior so present to find the sound gible. It has been suggested but the best six survets as in so a submitte wite the commit

phone to be

Per, etc. R. Is infactive, times grant, and where a strenged a it subth is at a size the the plant to be down to be have a section, in the wind of a second or age 8 HE strated from the comes of these with the so flating laffmally so to i to are more articl.

Obs. If one to occurs so an accrease matery in grate les, grateses appears and pagstates and the second of the s

at the part of the second of the part of t As to a to E organize to the first to the top or in the country to the country of the country to 
It I worked come to the country of the annual tenters die, there the, I have

End I control forth to a fill months I see to be more received to the second of the second to the second of the second to the second of the se on Norman, in the serviced a participation of disternion areas. It is produced tiponals fig.

Use. My water to be object and special therein order which is used in the name facture

of intendescent grateful manties.

Betrelate to the Ve Vin 140, a fametre smally massive Atomic strucha a - . "The latter of bearing near hand and sale and then the further-

conte from be by the set which is the set of the very model of the Correct Correct Constants and October when the set of 
Allert arts &

Monamobile An antimorate of sent rop and superimes cale up in part Rabballa I suggest to establishment may be the first of the first transfer than in the contract of the yells wish or live which green. From the Harring mine, Payeberg, near Pershaug, Verminal,

Carminate Perhaps Ph. Ast & 101 c Ast .. Orthodoxone In clusters of time position who in softenous forms H=3 s (, -41 has a point the form of the Romannian form  $\beta=20$ ). From the Large came a Hochasten, in Respectively. stock of Cornwall Reported from Magnet Transconts.

Georgiadésite. Phy: AsO, p.3PhCl. Orthorhombie In small crystals with hexagonations to H=3h (L=1) has y begins the following of the following the property of Az pl 010 Z=c and  $\beta=21$ . 25 larger bound on

sail vitters at Laur II. Greece

Pucherite. Burn it variable, Bible, in small orthorhombie crystain. Cleavage (60). If = 4. G = 7.25. our requisiblement Options: As ps. 100. K = c. and a = 2.41, A = 2.50. v = 2.5. other ingreducts, a < 2.5 = 10°. From the Pucher mine Schneducts Santony and from District at Santony Ulcrure, thense Hirschberg, Thurungan. From São Jose de Bressota, Minas Gernes, Brund, San Diege Co.,

Armangue, Mr. Astler, Retaining shouthchested Primatic halat. H = 4. [ = 12" | or basis compage user bases strest brown. I rom Langtonishyling,

Vertiting to Sweeten.

# Triphylite Group. Orthorhombic

9.9 6 Trophylite L. Fr Mr PO. 0.4348 1 0.5265 L. W. D. PO. Litheuphilite Natrophade  $NaMnPO_{i}$ 

Orthophosphates of an alkali metal, lithum or sodium, with free and man-MADDRE.

### TRIPHYLITE-LITHIOPEILITE.

Orth chamber Axes a b c = 0.4318 1 0 5265 Crastals ruce usunly come at fires sheven (on a st masove coass), to con pact

( manage com, perfect held) nearly person mellin interrupted Fracture is even to subserve heaved. H = 4 5 5 to = 44, 456 I water virtualize! restrained to air grown shoggers to his only in trap of the hand theat tept a year was a clevel not to the attention of the grayed white. Transparent to travel cent of housel are very with the composet in latherst core press +, with tx pl 001 , B = 168 2V = 6s for there's w 9 per cen Fet) 2 = 1.69 21 = 1 for variety with 26, 6 per cent (e0). Triphy ite is optically -, with Az pl. (100), p = 1.70, 2V = 0 34

Comp. A plusphate of iron manganese and letter or Lathe, Mn P(). entry ag from it I a a gray of the train to the realmonpink of cove-brown attriornings, with but hits con-

Typical Triphyl of a Life 90, a Philephoral pertox is 450, from probable 48.5, 1 th a Dr. - 100 Tr. 1 fr for at 12 Tr., - 11 = rise pert life 45 il manigorieme per termine, 45 il 1 = 9 = 100 to the are the over a present

Project. In braceased to some time a resultance, one and street and gives off treets if water. It is force at 10 to one in the or an it of too and it alreads, which a major force on the contract of the other or and the street of the other or and the other or an mar at 1 mangations the true reaction is traine a pure I translate. Some le la brette-

who give water

Obs. Found to reservable and popular to graphics associated with specialisms berg to remaining graph in the error for his of a figure at the origin we tag enablished of Benefit and of constant and denoted an area bispect of toward the despite the first from better on a form of the origin of the border. The ne -teles in the halament for the first in tention of resistant and with treated world. I do Marsel and a of Harriege a for write America, Harry share a Same I from you, throught, and going family in a smooth to its containing three phosphates.

I übsophibite occurs at Branchville Surfield Co Connecticut Ago at Maine from Vorway at not o and Pean, the trowogen o and from Paul San Ingo o the estimate

Names from fathern and golds from

Natrophate. NaMaPit, New troposite a form thesis message desvable.  $\{1 = 4 + 5, C_1 = 3.41 \text{ heads } 1 \le 360, \dots \text{ of deep where the contract of the contract o$ man, a < v. Occurs sparingly at Branchville, Fairbeld on Connectical

Breftonite Fe, Ma. ( s. P.O. Morochair Lamel at Basal deswage H = L. Colors with a party state of the party of th

Color of Foundation and to make them the or me stronger. Lorder Land Stronger Light and Department Stronger Light and Color of the Colo till to green all with the creater arrows . The set of the content of a second set of the I st a = 1 50 1 60 Createds from all sports a and one grant or a grounded want maxica regiment at 13 = 5 to a \$104 hours at home 5 year or troops a court baliny I tall assessment with war ste. May be a mer set of a note group

Berylonate & what of and a and are and a restale about prismatic to the our arthory the agent still meters the general to send if send if the first to the our arthory the send of the se

blue to blue-gray Strongly passedirate Found at Niesterpoons, near Schmandologi, Samuel

# Apalite Group

General formula Apaute		hor-apatic / = 0 7340
Pyromorphite	PEC PE, PUL	0.7362
Mimetite	PECLPS, ASOM	0.7224
Vanadinite	(PECLPS, VOA)	0.7122

In a ld tion to the above species, there are any certain intermediate commonwis containing lead and calc its others was thoughous and arectar or arects or I apadion so noted beyond. Further the rure cause a arm one grains the west a to beyong a thin on the contrade tao, cateff is prosent a regular the fail resent or appoint A probable member of the group, moterir contains (Vin with and SO, h and how to usual transals Fermings con and stropts in

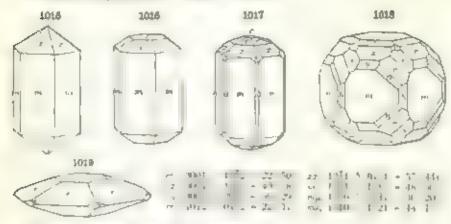
The species of the Aratite Guite crystall is in the bezagonal system, but an show, or her by the sole-pana c faces, or in steading figures, that they belong to the traverantida, chose p 116. They are elements phosphases, arsenates, valualistes of case on or tend also a anganese or believen or fluorine. The latter esement is probably present as a univalent radical Cal (or CaCl), etc., in general RF for RCl, replacing one hydrogen atom in

the acrd Ha(POd), so that the general formula is RFoR, POds, and simularly for the argenates. This is a more correct way of viewing the composition than

the other method sometimes adopted, viz., 3R, PCor. RF2 etc.

### APATITE.

Hexagonal-tripyramidal. Axis  $\epsilon = 0.7346$ .



frest is very lig from long prior he to short trish our and that r Also all 1 mar of lord for wall a historic retractor a re-monaged to I in ressive, a ruch reign titler to compact. A car of his a war without a in the unit of the Landson of which contents of the ax distance yet above.

through courts covered metall top so bentun cond al and a sea the de H = a sone case than 6 topose G = 31. 3 24 PPENTUR | IN T 5 PPHUS TO TO TO BE OF THE OWNER OF THE WIND (mor que de ser gran 11, et gran fan e , e a nope me af e interest and gradest gradest feet for a profession of the press, to obtain Or en y - Book general a war fait 1648, e - 1650 1643

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her Akt.

4. For combine making proven to the possible moreographic in course to Car Car (4.5), cand histografie v to Castl'acithi PO.).

I I prosp from the I market have further Pitt en 1 has to a special and the at the mind pourty have any to be an expense of the property of the p er te d oc. 19 ti ending as post or opin for a forman, to a reserve real new or stand a secondary

pheephate

Comp. - For Fluor-spatte of aftin, Po. and for Chlor-apatte (CaCl tagePOsts, also written Markoutal, and Markoth Catly Larry are also intermediate compounds containing both fluoring and chloring. The percentage composition for these normal varieties is as follows.

Flore-openies P<sub>1</sub>O<sub>1</sub> 42 3 CaO 55 5 F 3 8 = 101 6 or Ca<sub>2</sub>P<sub>1</sub>O<sub>1</sub> 92 25 CaF<sub>1</sub> 7 75 = 100 Ca<sub>2</sub>O<sub>2</sub>-openies P<sub>2</sub>O<sub>1</sub> 41 0 CaO 55 8 Cl 6 8 = 101 6 or Ca<sub>2</sub>P<sub>2</sub>O<sub>3</sub> 89 4 CaCl<sub>2</sub> 10 6 = 100

Fluor-apartite is much more common than the other variety. here belongs the apartite of the Alpe by air, or Lawrence to New York Canada. Apartice is which charine is presen-

ment are rare. this is true of some Norwegon, kill is

Pyracte BB a the forego faces with lifter to on the edges F = 4.5 & coloring the flator red tich veilles meantened with a lympor and hard her ed court the flator pulls on green minorhoriz are historiales a by the norman forth south yielding with and with a copy a permutate contrate all the sale allowed for a process of a contrate of a contrate will get a adjust the sale allowed for a sale a

Diff characteries by a man in arranging form in end or than beryl, being prescribed by a kinds loca not offers one is a like sale to , difficultly facilitie, yields a

gree its me it it after bring toolstened with sulph or and

Micro. Recognized in time sections by the consense; high relief extremely low bire-fragrance however or sites alterney a distinct axis figure a basis sections the preference on the numbers; sections removed range a sove gray of the treat struct parallel extract a not beginner extension, color nar form, not of solor and classage, and by the rude cross parting seen as as amount exacts a ressing the primit.

Artif Spott et al. e prepares artificially by fining codium phosphate with calcium

fluoride or en main chloride

Obe. Apartice to a widely distributed transeral, occurring to micke of various land ages to appropriate the property of the control of the property of the control of the property of the control of the control of the property of the control of the

per ving material id wood

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taus more for in Mines "rande San Dings to

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Aprile and phosphate rack are used chiefly as sources of mineral feetilisters. Use. Some owner to be a secret war a set of apart to man be used as gon staying. The removal is

the soft homeographic series is descent to the programs.

Sharements A car a steel car to job applicate to employmenting the phosphorite of Staffe Contractly in the re- all restriction to make the rese and radiating it is the right. of the fation of earliest od waters. H = 4 t. = 112% t hat such to hark green, green all yourse. See that are and to p. Till. Proposition on p. Till has a m. far company at on Take or from them sie, I seemark, Norway, and elsewhere, is sin, say with simil, and

b ton 2 " as par , Cali Callin In notisies Copplerents one Probably col-15 10% E lords. Corr book to - in him toward so himk from a non-widespread to the phopologies of the Chrane district, Russia, as a connect, as a replacement of organic re-

Tracks, or or an ice

Pode ite | 0 at PO at Cal Co. Heagernal It correscone priminate creatals, also In appear, the C - 31 1 my very a through the control may be the first On your avenue in the phosphore of the front cour the phosp River Indolin, southern

Research Service and to and extended at an

Scabite I can or swenger, related to the species of the Aparite Croup. Creatals hering mal prismie is it can confirm to the H = 5 for a spirit of the result of the Rambing mine Payaberg, near live borg and at Jacobsberg in the Nammark district. Am at Franchis, Somer Co., New erses.

Permorite: A member of the Apottle Group (Ca,Sr aCa OH, Foll P, Lattice, III = 5. 1 = 2.52 to for pair public with to white I reason. - w = 1.66

From I with management ages at his pair blue, with district (see in Procures, Inc. of Wilkeste Day Pitter (at 1, 0 a, with a (at Petter a neutral of Coulds Group Hi regulated B = 5 ( o 22 Pass is at 5.5. Dissources in according to extend on the could be at the country of the Impetone of Crestmore, Tuvernite Co., Canfornia.

# PYROMORPHITE. Green Lead Ore.

Horagonal-tripyramidal Axis c = 0.7362

Crystas prisulatic, often in rounded barrel-shaped forms, also in branching groups of prantate crystals in nearly parallel position, tapering down to a

1020

sleader point. Often globular remform, and boars onlas or or wart-like shapes,

with usual v a subcolumnar structure, also fibre is, and grander

Cleavage satisfies, r 101) in traces. Fro three subscrickedal uneven Britise  $\hat{H} = 3.5 + G = 6.5 \cdot 71 \text{ mosely, when point, } 5.9.5.5, when con$ taining line Laster resinous. Color green, yet w and trown, of different shades, schotimes was yellow and the mange yellow, also graylsh white to milk white. Streak white sometimes yellowish Babtestaparent to subtranslatent. Option y — ω = 2·050 · · = 2·042 At times when containing arsenie shows weak bancul character

Yas, ! Ordinary, (a) In organile an described, we estimes vehicle and a resident forms resembling cames to sensor analogs of the sensor for and mass like aggregations to some such years and it is not a consecutive. tent having the surface angular of Fibrour a termular massive f

Earthy report of Containing I was cone brown of different elastes, we have all grave sale various to meanly white attends white, to = 5 miles by Harris i supriste expetals, sounds is gre do, gie or more are Marate from Man a Releasing to a brown seasty. Vagareter at a solar

AD a 10 page, from a smaller man Bern je that c, benave; color yallow, graenish or grayah, G + 5 m2 3 Co maferous come behand to apparen gr 4 h 20 m a color green

to white to - 5 5-00 5. Paranamorphous a after guena, he represente

Comp. — (PbCl Pb<sub>1</sub>(PO<sub>1</sub>), or also written 3Pb<sub>1</sub>P<sub>2</sub>O<sub>2</sub> PbCl<sub>1</sub> ≈ Ph sephorus centrar in 15.7, lead protoxide 82.2, chlorine 2.6 - 100 h, or Lead prosphate 89 7, lead chlorade 10 3 = 100.

The phosphorus is often replaced by greenic and as the amount increases the species

passes title proposition. Compare the representation and to a consideration of

Pyragete. In the count tire gives a works a branche of each that he BB in the forecast tuess easily F = 15 destoring the flame to ad green in charcoal fuses without per school to a graduate which on case of cases one is erea that a post scales form, where the could account white for a said of cult and mand the among we have been read eather. We do cor's up repround violen toping a read; nome variation emitain amone, and give the const of garde in R.F. on charroad. So, this is a tric as t

Battage wheel by its hamagona; furm, high specific gravity restrous luster,

blampine characters Pyromorphile is a mineral of secondary origin, found frequerity in lead deposits but solding it large amounts. It has recalled through the action of prosphere and appear guern and certainte. The chief local rice ( or be occurrence of percentage to especial a cristials, I low From Bereausk, near Eksternling, and M.s. Ruses. In Co. despeyable at Mics. Pribrace, and Binatadt, Beberou, and School, is be model to Shownkas. In Sassiny at Zachopau and near Freiberg, in Heisen-Naman in fine creation at Friedrickensgen mar Fins. in Saden at Hotsgrand in the Dank Forest, at Linuxul at the Hars Miss. In France the mines of Haeigenst and of him as note in Figure 18 for any have formulad fine specimens of a brown color, note from Pency band Private being and from Cross-age-Mines Vorges. Fine crystals come from Hices, Chione were Sensit In England from Correspond and from Roughten Cell, Combernand, as I a Sensite Int. Leading, Lanack. From Mindous, French Congo. Occars at Broken Hall. New South Wales.

In the United States pyromorphits occurs in Pennsylvania at the Wheatier, in or, Phone wills, Chester Co. and at Porkiomes. Mentgemery Co. In Davidson o, North Caronna. From Plaho in the Coone of Alene district in Shoshone Co., at burke, Marc.

Mulan, and Wardner.

Named from res. Are, seech, form, aduding to the crystalline form the globale assumes co county. This species passes into intrastita.

Use. - A mount are of read.

#### MIMETITE. Minustesite.

Hexagonal tripyramidal Axis  $\epsilon = 0.7224$ .

Habit of crystals I ke pyromorphite, a metimes rounded to globular forms

Also in mammillary crusts.

(Jeavage x 1011) imperiest Fracture uneven. Brittle, H=3.5G = 70 7 35 Luster resmana. Calor page we ow, passing nto brown, orange-yer ow, white or co-or sa. Streak white or nearly so. Sub-rarsparent to translatent Optically  $\omega = 2.135 \epsilon = 2.120$ . Sometimes shows biaxial character

Var I that many to In expectate, usually it rounded appropriate to Parallery or filating to so, uspecially marked a a vienty of St. I'v con to Beneziny, France, some or or 160 adheron, the straw versus at color of the color of th

consist of the active to enter the nature from any other, classed generated to brown and by which

red; contains 3 per ceel PyOp

Comp. (PhCl)Pb<sub>1</sub>(Ast)<sub>2</sub>), also written 3Pb<sub>2</sub>Ar<sub>2</sub>O<sub>2</sub> PhCl<sub>2</sub> = Arsen<sub>3</sub>c pe dex de 23.2 leas protox de 74.6, chlorine 2.4 = 100.5, or Leas arrenate 90.7, lead of tide 9:3 = 1 10

I' splores repaire the arsene in part, and edeam the lead Enduchde

p. 700 is intermediate between miniette and valuable to

Pyr, etc. In the closed take iten are semble. BB (see at 1 and on charcon) given to R.P. up after in what and is one of the part to a seal, contag he come at First with tend children, and paser with amount transfer any reas exact behalfer, in the

BHT DE

Minoritie and fairly tries, many opening to be form the part to upo te in local Oline the world this ture intergrate were a far the in the part a some to with last notice at the endmander I see as a the Sarrie at the page in tail I a govern to the facts notes and a set is found that a state of the facts of the state of the st

he states where moments has been found at the Wheatley mone, Plannagelle, China

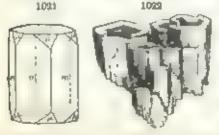
ter to fer up lymous As Freshot better 1 to a

A red from passing, trevaler of closely research is syre-correcte. Une. - A resource ore of lead.

#### VANADINITE.

Hexagonno-tri vramulal Axis x = 0.7122

t rystals prema ie, with smooth fores and shirp edges, senieticus exvero-



ons, the erest is hell so prisms to in counded forms and in paradel greate medike peropertible e liams an ed globules or incrustations.

Fracture uneven, or flat conchoidal. Brittle. H. = 2-75-3. G. = 6 60 7 10 Lunter of surface of fracture resinous. Color deep ruby rest. ages brownish yellow, straw-yell w. recited brown. Street white or yellaw, sh Subtranslacent to open c.

Optically -  $\omega = 2.354$ rightarrow = 2.299For endichite  $\omega = 2.25$ ,  $\epsilon = 2.20$ .

Comp.  $(PhC1 Ph_1(VO_c)_3)$ , also written  $3Ph_1V_1O_k PhC_{kj} = Variadium$ pentoxide 194, lead protoxide 787, chloring 2.5 = 1006, or Lead vanishite 90.2, lead chloride 9.8 = 100

Physpacius is sparingly present, also scinetimes arsenic, both replacing

vanadram In endirchite the ratio of V As = 1 I nearly

Pyr, etc. - In the cosed tabe decrepatates and yields a faint white subbruste. It II fuses and an ease of to a social officer mais, we chan I a year is examine level and a control of the little te, after extendent, as using transparately the black rest in gives will sal of phis shorm an execuld green band in R.F., which becomes aght velices

15 (1) [hear many (1) hyuppet, et per

Ohn. Valuable is an accounted, remark untilly found a mental feat the wester. the reason to a restare at Heres at near Ekuterinburg in to I in Ma pear beauand all and the Austria out the Source No. to All endown S, and I are I in So the plant W movember i champress and from Land by Larrary Large or a nearer cand at Lighting Mathemat. Midden in the State of Minimum from Ottown in the Minimum intrait, Francount Francisco de Serra de Conclus, Argentina. Vacada le mas de modest from Zara, ar. Hidago, Verseu. Is too fig. of submitted parties francount of the supring regions of Arizona and New Mexico.

often appropriate with whether and entering the little retail by class from the area at one Red ..., nite, ate a Y time! ..., a Ardinard deep res ervotous, from he Maramotta gold to send Set to mean tennes to the Catal a Mits Plant Co, for it is Nd Yu an are near consequences from the transport of an open to be an absolute and the transport of the trans trie , Contro In New Mexico Spering o , a Lake tollog well have and it do no, wear Georgalown, Orant Ca., and as Iva y usar Magdalesa, Somero Co. From too Busck L. Hs. South Dekots.

A source of youngly, a and a reason ore of lead Use

The symmetry of the sectionary bear of the section and an extractly of multiplicity process of Color yields with the formula of the section of 1988, and 1988 and the section of the secti From Vermin I Sweets at Lingburghyttan and Papiters usur Persberg. Franklin Stones, tot., New Jersey

## Ragnerite Group. Monochaic

		£L.	- 4	0	в	
Wagnerite	(MgF MgPO,	1.9145	-1	1 5050,	71" 53"	
Triplate	(RIORPO), R = Fe Mn = 2 1, 1	· 1 etc				
Triploidite	(ROH RPO, R=Mn , Fe=3 )	1.8572	1	1 4925,	719 484	
Adulte	(MgOH CaAsO <sub>4</sub>	2:1978	1	1 56-12,	73° 15'	
Tilasite	(Mgh/CuAsO <sub>4</sub>					
Sarkinity	(MnOH)MnAsO <sub>1</sub>	2.0017	: 1	1.5154;	624 134	*

Phosphates tand arsenates of magnesium (edictin), ron and manganese containing fluzing (also hydroxyl) - Formula R4FPO4 or (RF)RPO4, or c.

#### WAGNERITE.

Montehnic. Axes, see above. Crystals sometimes large and course Also massave.

Cleavage a(100 , n(110) imperfect, c(001) in traces. Fracture uneven and spintery. Britile H = 5.5.5. G = 3.07.3.14Luster vitreous. Streak white Court yellow, of different shades; often grayan, also fleah-red, greenish Translatent Optically +. Ax pl (010) Z A caxis = 21°.  $2V = 26^{\circ} \text{ (approx.)}$   $\alpha = 1.569$ .  $\beta = 1.570$   $\gamma = 1.582$ .

Comp. A fluo-phosphate of magnessian, (MgF MgPO, or Mg.P.Os. MgF<sub>1</sub> = Phosphorus pentonde 43.8 magnesia 49.3, fluorine 11.8 = 104.9, deduct (Q = 2F, 49 = 100. A little calcium replaces part of the magnesium.

Pyr., etc. - BR in the forceps fuses at 4 to a greenish gray glass mostened with oulyds are well covers the flarer South green. With been rem who for you the fundon with social efferences, but is not con ; a sty desolved grown a faint mangar me react in. Heare a for flammar. Somble in maint and hydrochloric acids. With sulpharic acid everyon future of the or of more person

Obs. Buggers in small highly modified creating occurs in the valley of Höllengrature near Western and an Kasangrahen was Basets Interior a Sainteery, A sixta. Kijewa-

for many recleasions also in coarse crystans is from Harrend and hy-created, over Bond is escipars, Norway Spodiosite council thro-phosphate, perhaps Cab and by In flattened presents monter the formation (fravogen 0) belong 60, page H = 5 G = 254 leff by fundage (oper national or only + a = 1000 3 = 1000 21 = 6.5 Personal of Section, at the Syttem Eran mate, morth of Fagustan, and from Nordmark

#### TRIPLITE.

Monoclinic Massive, imperfectly crystalline. Cleavage: unequal in two direct one perpendicular to each other, our much for more distinct Fracture small conchordan H = 4.55. Cl = 3.44.38. Luster reschools, ine, nong to actamas, the Color brown or blackish brown Streak ye., mish gray or brown. Subcransmernt to opa pre. Optically + Ax of. (010) Z ^ a axes = 42° Indices vary with composition, 165-168 2V large Strong dispersion, p > b.

Comp. a.F RPO, or R PaO, RF, with R = Fe and Ma, also Co and Mg The rath varies widely from he Mn = 1 I to 2 I truncaclite.

1 2 1 7

Public due is a variety from Horsey-berg, near by Vermand, parties contains time

Pyra, each B. F. and each a set I for a black magnetic globals monstoner with the of the pull course the flame to say green. We have not to be an active suppression for the pull course of the flame to say green the haven a feel green as a first course of the course of the pull c

Che I restrict to sent the street of the same and a street to sent the sent the sent to sent the sent to sent the sent the sent to sent the sent Crechestron a It was over any forms at there to your Lipsuger, He to be one, brace Zuredie a sie rich range, is from assenter per 1800 Buyana how I in the series led contains, Argeria a, in part a term to a track to become to the view was recorded world a text els. Vace and vide, hardend to, Consecut that length to six bet "While I had a Neva a

CHIPMER A problemat a this spirate remits to the security gan embedded samplement problems. For v and replaces H = 5 ( v = 14) have V = 0 . From Last Reverton the order over Henry V = 0 such as the second of the second Henry V = 0.

Cr. w th laketa

Trp. dite. Like triplate, but with the Frenance of CH. Manuscanic Community in the uline opposition had not be relational entropy that writer the 455 to 7 for a large transfer to reach to reach the reac Strong the arrive a see From Brie bythe Particle C. Capite Strat. Also from Pagette dorf our Phones Chember Bayana

Ade to Mg(1 mAst), M scanne three see p. 700 when measure 11 = K,  $C = c_1A$  (or or given or graved vectors  $C_1$  may  $c_2$  and  $C_3$  or  $C_4$  o

Sur er at Jaco where over N commen one, at 14, g month we

To saide. Like a death, but residant if one Morney one if a 5 c, = 3-8 eg to f / 2 - hand a - 1840 a - 1 at y - 1 from Linguishertan.

bette and Sweden. As mored at his a lager, I am a state (extra Processes the his Sarkmite Visitly Madad), an amount rice that is an anomal or and format Change of the Hood of the 4 th 18 1 - 4 th 18 1 and the rice and the rich red that a lager than a first that the first red that the same of Processes and the same than a Processes, the same than a processes and 
Vermland Sweden also at Lingbanshvitan Pulsursonite and Xunthursonite from the Sid mine Oyeter Sweden and Caroline some from Facilities, Sweden are come alls the more Arsenociante. ZMn ( H ; Mn; tst.). Orthodombie Convage 01 Color red. Lingtarahyttan, Vermand Sweden

Pleachene X - Y = colories, Z = pate green. Found masters at Sarro Branco, Piruby,

Parah La Henra

Savongude Ferhaps "R.P.O. RF.; R = Fe, Mr., Cu. Monoclinic? In irregular all parties of distorted on a les plates or from Devering with fibre of an encaure of the age as provided as a cross of the attention exposure to be a green, or become the control of the 6 1725 though with a state and tures to n a page at to ver hear Mathamore, Sousia. Also found in a small pagematite vem in Descring, New Hampshire

Trigonite [1]? An total. More chine-clinohedral in small wedge chaped crystam I of stricks age.

11 - 1 (1 - 1) to the sage of the control of

Herdwise A flux, we are done in and care at Caffee (a) for the mater of the month of the policy of the month of the control of the month of the control of the month of the control of the have the an a free word before come and Newry in radial abrous aggregates , and in Andrewseggen to, at tabum and Polan !

The folk a ng numerals are sureful at 1 are commonly placed together in the Hamiltonian

the in , the are men or and it's hide on it the Aturate in in

Goyarita. Have a Atmost street street from it and stronton. PrAly Oll v The perhaps to the whole the control of the control the property language, "waterpayed organis shought to be a new execute and cultured

Correct to. A basic reb of basic of alice of a barriers feath on a creation fact. It is a " " where it is not realled to the are an assumed to the controlled to the area of the controlled to t Cobring so and while the think a well to be something in-15 - 7 (. - ) ment so to if Visas terror train from notice of the more action in eraps and of

Planbagumente y tous, now a rusa a lith the Rememble to be a substitution of the Rememble to be a substitution of the substitu the constraint of plum seemen

Processing to assume the second control of t yes will fell as to the property of the proper

Prets. and Daniantina, Mass Committee Drink

Harride. — A basic phosphote and stip-hate of alconomic and structure, (Sc.CatO) 

Home a transception of a major to a second the one defined of which of the second to t From here free me up have

Durang to the manager of the management of the m to Ope. I so the to all all all out coloriese from larrage,

#### AMBLYGONITE. Hebronite.

Tri line Crystals argue and coarse forms much discret family r pays do to red in tax and read of a covere. Pody ave but a swamping being in

the vage (100) perfect, with perry baser of 100 somewhat was so vires in a Colonia mention to the terms of the transfer of the 100 = 75 30 √ 001 ∧ (. p = 74 to rM 901) ∧ (f10 = 92 26' be et an unever to subsectionally brittle II will. (5 m 301 316) I, after 51 reals to greater 1 DO, pears to r white to pade greaters, blast, schowish, graish or now job white Steek we to Sill rate post of the court of the first of the period 21 - 50" With previous the by broady content becomes operally # with legier it jees

A floophosphate I has been at 1 three 1 All tell Plan. South in often replicate part of the analytical water was be C Stimbling C.

begins at those give the times mantelegade to the hydroxyl end of the seer a and anonygon to te the far rate cad

Par etc. In he would be a classifier which at a high real me ad and ever also there are to the same of the contract of the c to go Course to the transfer of the second that the property of the second to the seco

Diff. The great of the property of the propert pertor even to easite to a ta Moral to Malportina Para le re Vilre en se le res e le ce ani Val re Sparing y at le re de se le region de la legal de la diference de le region de la regi

Fremoute Street Sala Mall Mall Page Trie commence of the comment of the same with rough farms. Three electrons for a manager to a Popular three charters to the planet of the commence of the commenc that we ment that the state of the Colorado.

## B. Basic Phosphates

The section includes a series of well-characterized beare phosphates, a number of which fall into the Orivetate Greep. Acid phosphates are moreson of by one species only, the little his was a markle, probably HC aftern вее р. 710.

## Olivenite Group. Orthorhom ne

		0 0	ď
Olivenite	$Cu_{\theta} \circ EDA_{\theta}O_{\theta}$	0.43394 1	0.6726
Libethenite	(dis )[] PO <sub>4</sub>	U Septil 1	0.7319
Adamite	Zis + H) AsO <sub>4</sub>	0.5733 1	0.7158
Descloszite	TreZo,Cu, cOR VO;		
	$a \ b \ c = 0.6368$ , 0.8045 or $\{a:b:c\}$	= 0.9562 : 1	0.8045

The Oriverstry Chot Policia les seyeral basic phosphales, que aparentes et inf copper zine, and lend, with the general firm in ROH R.O. ROH it is a etc. They crossed our in the certificate a large after the first for it is a be noted that thought in a resepose fact out as and one member for the upported Group, p. 709, water, also includes last for more

#### OLIVENITE.

Orthorhombie: Axes  $a = b = 0.9306 \pm 0.6726$ 

Crastals prisonice often accurat. Also globular and reliform, induting a L. r. as, bhers straight and diverged, ritely

irregion a same curvey and or a fight pulse

Cheerings multill, 5 010), 7 01,1 and traces. I meet be empchieda to uneven Britle II - 3 G - \$1.44 Lagter relating extracts afterward of same blooms car process peoply to over various shades of of ve-green, prosent the look, sisker, protachio-, and blackish green was here and wood-looks were times straw yellow and gravish was ear Strong over great a LOUGH Sulary aspects to oparity tiph by a persone sometimes A Ax pl 2 (00) Z hoxis Indicas variable, π = 1.785 4.795 2V nearly 90° Strong dispersion, ρ s c for optically +

of P. Hoy we want of probable within the well who may I wan be for given



Vist is to distribute to the control of the species 
Comp. Cb/AseO<sub>1</sub> Cu + H = r-(CuD AseO<sub>2</sub> RsD = Asserts pretoner + 10.7). cupric exide 50.1, water 3.2 = 100

Pyra six In the chance the grove water BB we at 2 coloring the flow language green so I on order the seal was appropriately as 2018 at 2011 and a deflugations, given of assets of the a common or a result from the common of the commo

were the wife and teller to program when the most the transfer of the angles of the angles of the angles of the second of the se must foresteen a Decombine topped at I am sele near than So at War three by the

United States at various numer in the neighborhood of Eureka, Their district I tab, both in

erry are and as constanguer. The came diverse as men is the vergrees come

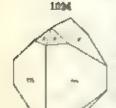
Dulinte. Bearings to more to group with approximate a half the apper replaced by lead, 15. a., to 15. C. H. In named of and the course or reduced by the course of reduced and the course of reduced and the course of reduced and the course of the course

Higginale to at H both, O-Openhan or Star promoter repotent H = 1%, 1, 1 h, tues tues to Optically to place 1 - 2 and of = 1848, 4 = 1 of a a 1 of 14 14 month of Disperson, a 5 . Pleachroic, green, yeak a green

brangmen I rosp Haggins mane, Busbee, ochase ( a , Artrona.

#### LIBETHERITE

Orthorhombic Axes a = b = 0.9601 + 0.7019



In created senally small short prematic in habit often united in frames. And go become or rendorm and compact

Cleavage at 1000, 500,00 very indistinct. Fracture subcourbor his to uneven British H = 4 (, = 36-38 Luster restrous. Color ouve-group, geprenly dark, Strenk e ve-green. I muslucent to soft most cent. Optically -Ax pl = 0.1 1 = 6 ax s  $\alpha = 1.702$ ,  $\beta = 1.745$   $\gamma =$ 1786 2V near v 90° wants depend to > 0

Comp. CosP.O. Co-OH s or 10 p P.O. H.O = Phoephorne pentoxule 29/8, expete oxide 66/4, water 3/8 = 100.

Pyr, etc. the council the wests mater and home black. Hill force at a and country the finite of rait green. On the rich who is go to the propper, employing a sethe visit of section to the state that is the great of the purphedistrates and On the dig to it the P new step in it is over the him to the left

Obs. In strate to the restrict representation of the figure parties to an fixed Oth I at a desired of the second of the light of the ligh

Adamste 7 shows to tell , In straid orthorner or stage offer grouped the The state of the s This is at the act of red all act is not be they begin the court near the sent then the technique of their a Chile

Developper byling to O or to the fact now given a late of the Profit. At the other area at the rise I desired to present an arranged with about the other content area I green that risk goes which are not become the other object. The incoming time of the little of the other object are a second or the other object. and the state of t party of high lors we brook server made and the first of 
her sade to a mineral of accordance wight four I accordingly to lead one deposits prophy changes for (on , ) from de off & the da orf face specimens 1 do Abried hear farmed when South West Of on 18 store of the side

remove points in the Seem to Corlobs, Argentina. In the United States in New Memors at last at Lase Valley Servers over enceptown toward to and at Magitair a. For over the St. Archita over in at Schults over thesele. Prop. o. Communication of the he was an improvement and make are or or an entere and reading measure with the latest eir riture it Mezur ... he status it has I tus Pot at Zarateras at it cataguai o . A at. or The to Marine a provide the second of Manchester Company, England, Also noted from Tour one the nest Host them.

or ners may be seet, also lesslourte. Manage is nodular stalaction forms C - 5 pe for a committee resident a man greet al. En en Holag a come lores burge a basen even a y. The same way be true of senerem from balts new Souter-

while or be. Rherse Bayana Commun.

Perspendite 4 M 12 1 12 141 Forbage a deministe in which all the size and Turb rate Zuliday or H. Terror Crystals structed and rounded frequently

to show he aggree on I effect beam instage H = 17 (a = 41 beam instage to not make to pain set in the control of the stage 
Brackebuschite " V Le , Hatt Manager Propagator revolute C for black S gramman to me suspens ) and Z wreturn town Options; + \$ = 2.36 From the State of these in Argentina

Discourse Composition analyses excepted as Physics, Magnete between latter of the contract of

The to horne and a total expension on the Laser to he had a surface that the laser to he had a surface that the laser to he had been a surfaced as the surface to the laser to he had been a surfaced as the surface to yes going At the his his works in a grown or properties for military on The best of the second of the the two water is not as we as not about 12 go to a

Formary is the term of the proposition of the property of the broth facult over their bouth West Africa.

## CLINOCLASITE. Aphanies.

Monorthic Area b c = 1,9080 1 3,8507 8 = 90° 30°

Cryst is prosper a to 110 - new congulated. It has a few grouped in brack spaces a forms. Also massive, because ereal or removem, structure

( emage 00) highly perfect. Brittle H = 25.3 (c = 4.19.4.37) leaser openeds elevative s'recon la namona. Colorate eminas dans septigrie-green, externa y has also hore-green. Stress broad green. Subtransperent to translucent. Optically - Ax pl. 010; Z pearly a axis. Comp (174 p = 187, y = 191 2) to be un Strong dispersion p < .

Comp (154 p ), 30 p (1) cer 60 (1) And the lift of Arrente protestate

30 3, c ipric oxets 02 5, water 7 1 - 1001

Pyr, etc Same sa for olivenite

Oly to the train at conveil at the many at the Reducts of an

Ols to the common of common of the man of the fine and the man of in let le ge ops. I visit of pu

State 1 to Super to Co.Zn ) tat 2H.O Orthodoxolas France Persubstitution product of tension of a university, with it set copper area at Marshaulla, west of

hucico, Poland.

Cornelite (APA), II remorph is with the longuetate Optionly to the In the decrease of crystal create 1 > 1 = 1 t a color of t to 1s = 1s1 t color of t to 1s Beening Mikubeen, morthers Inhonorus and housings, Beigins Congre-

#### DUFRENITE. braunte

Menocker ? Crystals rure size and in listing. Usually massive, in

noduce r diates fil pers a r druss surface

Carrier D to perfor 100 distant \$1 = 154 G - 1234 I tour wiley, week Coher to a charge or or egreen or blacked great plant in Aposto to be a west of the Service as a ser given by forth had to no his page throlly place of the place of the place 1840 y as 1885. 25 mind of to the Army strong conjumping to ring \$ produce a primarile to great the rest brown. At the see whom you at prigraphic to with the real graph of the same of the

Comp. Decise I is part 1-190, I OH 21-60, P.O. (1), O = Phose

phorus pentoxice 27%, trop sessor and 620, water 16% = 100.

Pre etc. Have a so for a more for the man of the givet to be the more of the BR

F men enterty to a stag

Ches I fee to an experience of the first and the fee t When he is the and the second of the second

1028

Districts A hydrated arm promphate pertupe 2 heats that at viriletal transfer A regions of a 2 to 1 h 0 or others that is to do at left to a content of the arms of the perturbation of the content of th repliers reacts none and sat part masses from fatomer Bolom a Colet op cattain

#### LAZULITE.

Monochaic Axes a b c = 0.9750 | 1.6483, 8 \sim 89" 14"

Cryst de cauda, acute pyramidal in linhit. Also mas-

give, granular to estimate

Convige promision in listance Fractice upoven Britis H = 5-6 G = 11 Supter vidreous Color azure-blac, commonly a fine deep thic viewer, along one axis, and a pale green sh bage a stg mother Steenk white. Sultransi cent to opaque Obtacliv Ax pl (10 1 A c 4006 = -9  $\alpha = 1612$   $\beta = 1634$   $\gamma = 1643$ .  $2V = 69^{\circ}$  Pheochrone, X = cotorless, Y = Z = naureblue

Comp. = RAL(OH), PrOp of 2 MPO. Fe Mg (OID) with Fe Mg Ca, = 1 12, 1 8, 1 2 2 3 for 1 2 the formula requires: Phosphorus pentocade 45 4, shumum 32 6, iron protova le 7 7, in goesta 8 5, water 5.8 = 100.

Pyr., etc. - In the closed take a stens an L. elds water. In the forceps whitere, end ka open, swe stop, and we have fisien face to pre-to, contrag to the armen of green It is well what a loss had a war fire one of a rew oil the grown or that we to make one there are to seem out of a wine, the there are no a region of the grown of the self of the control of th popularity and memory

Obs. Los he come aly for the quests or juga attention in theorem at theorem at ware a bright and the bright of the state of an a bidan le Out iten States at the as or by a triver a Mr. o stan to be with the mains, are a the side may result to traves Ma law and on the grant will like a contarproperly for the

The in a tex to so berived from an trable word, and, maning house, and a mose to

the evenie the principal

Taylatock is 140, 241 Ollip Orthorh alter In control upper descript citizense, from the and a series of the property of the series of the 1 40, / c also w = 1 122, pt = 1 5.8, y = 1 514 24 = 74' From Taxastank Day white

He bread thanguest pit care time it, sternish about north Technique a trag-tention 1111 warriets of named as a first chount to a town a on the manager of a as placed as a first open to the same of the same placed in the same p

Kirrobte tyre o Probje tash to, Alcof, Compart D = 3.5 (. -3-08. I do y ale verber flor must the constitute of Westant, near has in next it ark-

hanne all a see Sweeter

That he so thwest of Macon a land have crosse. Penarted cen the Lan betrat I tak A lose so, musty in optical characters suggests that makes the p. 7%, a monthly with attentionaterite.

Dussertite. —  $Ca_1(A_0O_{1,2})$   $3 co(OH)_1$ . Hexagonal or becagonal rhombohodral. In small crystam, tabliar parameter to 0001. H = 3.5. G = 3.75. Color green. Un small . m = 1 87 a = 1 85 Pleachron in shades of greenish years. Decars as crusts on quarts at Diesel Dehar portheses of Hammon Maskho duse, Constantine, Agena.

Allectite. MnsAsyO, 4Mn/OH . Monoclinic to small brownish red prismatic Allectite. MasAsO, 4Mn/OH; Monochine In small brownish red prismatic crystast or tabular. Rib. Several inclusives tenewages. H = 4.6 Cl = 2.8. Fastale at 6. Optically = Ax pd. 1.00 for once. OHO for red and velow. X.A.C. axis = 50° a = 1.70, p = 1.78, p = 1.78. 25 very sami. Disparatio very strong. p > n. In Verticaed. Seeden, at the bloom man, Northark, and a. Lingborshyttan. Synadaphits. 2. Al, Min. AsO, 5Mn. OH. Monox mis. In principle attention, class in grains. H = 4.5 Cl = 3.6 Fastar fastile. Court brownish clack to black. Optically + Ax pd. 1.000 N.A. casis = 4.6° a = 1.90, g = 1.87, y = 1.90. 2V simul. From the Most mine, h ordinark, Vermand, Sweden.

Abodelph is. 5 Mn/O 2 Mo. M. 3.1, Asp. 1.5(0, 5Ho) Probably orthorhombic. In tablishment classification and the classification of the Most mine, h ordinark man, tractice. O = 3.573 (corr data red-formed inocolours brown stresh. Optically + a = 1.7244, y = 1.7493. 2V vory small. From

Lang' v shattan, Verman I, Sweden.

Flinking Shaker, 25th Olive In minute orthorhousing crystam, tabular cont. protects on testing the aggregates H = 4.5 G = 3.87 basely (unlike Court greet) to testing the aggregates H = 4.5 G = 3.87 basely (unlike Court greet) to the way of the latest X = 100 become green, Y = 100 and Y = 100 by a 100 to 100

Rateian A basic arounds of he year in certific tranganese and calculate. In orthothe m -crystain B=4 (  $\sim 4.15$  Infant is 1 magazine and canonic. to order throws  $C_{\gamma}$  food v + Az p) ( Z=n and a=1.777  $\rho=1.88$ ,  $\gamma=1.500$ . 21 large throws X=c are set  $Y=p_{min}$  yellow-brown,  $Z=r_{min}$  brother the M on the M of the M-strain bordeness, A contains a western

Assentablette Perhaps Ratt, Off Antique R = Mn Ca, also Pb. Mg R = Mn, also Pb. Mg R = C73 execution tripped copie

Manganost-hite Me Shah. Manchese? In small reds at 3 fibers and entended grams the safe (0,1), perfect Labor to Continue the safe (0,1), perfect Labor to Continue these (0,1), perfect Labor to Continue the safe (0,1), perfect Labor to (0,1) the safe 
From Schmeeberg, Saxony

## C. Normal Hydrous Phosphates, etc.

The only unpersont group among the normal hydrons phosphates is the monoeling \ IVIANTEE (1800)

Structe. (H,Mg)(), 6H/2. In aethorhombic bemanosphic crustate (Fig. 542 pt. 145 has agen. (6) perfect, (6) good H = 2 (a = 1.7 F aside W) our regionally Optimize — Ax pt. 130 Z = b axid. a = 1.495, a = 1open a phosphate in the processor of nationers. Such our a time true cann in taches of gunt's at a few harmone, and indicated for a long per oil.

Colimphania Laser offy Captain Ho. Company in variable, especially as to

water consent. Also contains small arounds of calcium partonate, fluoride suppliate, etc.

Amorphous. In layers suscephing gymn.te or opal. Concluidal fracture. H. = 2-5. O = 2.6 2.9 Diffic it y Cambie. Courtess or apow white lancopic. n = 1.57 1.63. Collaphan is a usually found in coral limestones which have been covered by beds of grante. From the aland of Southers in the West Insien, having been formed in the clovared cural reef by materation of the asks from the overtying giants. Monite is sunday from the islands Moves and Moreta in the West Indies, where it is associated with monthly IICaPO, which occurs in yellowarb white the ann creatant is optically + with 8 = 1515. And aromarly found to various localities in the apprent Partir Group. Material apparently pertical with collophanate found in nod des in a antidy mail near Great ., I oland, has been marked graduotite to doplanate is proposily an important countitient of the phosphorites asserbed agover hawatete p. 704

PERCONDUCTE Mg.P.O. 4 Ca.P.O. Ca.P.O.)? Massive, earthy Color spow-

white, deal From the West Indias

Repeite. Zn.Pst. 4H.O. thiburb object in minute prismatic crystals. Also the resilient passess. Three clearages 100 perfect, 0.00 good citiot, poor H = 3.2 G = 3. Define its familie. Color gray ab white translate from Broken H.H. show to order into it two is or heat one, or and it to gotte which have the matter or asymmetron Int differ a their option contactors. Both varieties are spineally and X=0 and in a hopein Z=0 and while as B-hopein Z=0 as c axes. Indeed for a-hopein are, c=1.5, Z=1.5, Z1 982 t 50 25 very a nell. Deved in pay ties in rates than at the rine makes of M resort, Bear no a lot Altenberg, mothwest of his lat hape a librariand a the broken Hill ruber, baselests, Asser found at Salmo, Neison mineng district, British Contaden, the hours ste

Phosphophyllite. - beautifully a rice phosphate with composition similar to be perte, RefPO<sub>43.4</sub>H<sub>2</sub>O Monacl is lost with argues assume to those of logic to. Clear ages 100 westers, 010 102 lumbert H = 3. Course to pure to regree Optically = Ax of 1 010 X = b axis.  $Y = abs = 50^\circ$  of 1 (35) n = 1 016,  $\gamma = 1$ 010,  $2V = 60^\circ$  from Hagenders near Physics in the Obserptor become

Paraliopath In P.O. 415,05 Super as for hopette. Teach or It may be tabulat erystem 100 with the situations (wireled or 00) Good covering 0 11 = 2.7 (1 = 1.5 Facts for the result topically 1 is a 1.614, 4 = 1.625, 5 = 1.637 27 large, beand at Bronce thill, Rhodens, also from Salaro School instrug districk British Columbia

Dickursonte - Dr.P.C. H.O with R - Mr. Fe, Narchieffy also Ca. E. Li. Mono-chie h. tabular pseudo-thorsholisdras cristials can had be intended to a second thronge OD perfect to a fit bonds seed in these to a green gross grows of the by a large of the plant of the bonds of 1655 1662 if the in to have been grown as a transfer in the bonds of Post of American ago ., Man e-

Fillewite. For mile an for occument te, but defecting presental angles. Monocarie, their form a consistent. Became character to grantifle rays in the research H = 4.5 for a 3 for bone a formula Connerway on the yellowish to real high trans. The contract of g = 10" d = 10"1 y = 1078, Il much Occurs sparing y of Brancharte, Partield Co., Connecticut

The three following species are reinted a composition and may be a createlline form Roselite. (Lot Algorith 2012) Tree or to much creates, often in 1 and apprecias aggregates. Lot electrising Orange species H = 3.8.4 and apprecias for a Courage of the courage o

 $\beta=1.725$  Serving emperiods,  $\rho=0$  From 8-1 neckery forms  $\rho=0.217$  Branchine  $\rho=0.211$  (respective to promise crystals crystals often united a radiative graph (beavage for H = )7 G = 3.27 branche Corpbie to white Optical  $\nu=0.211$  branche Corpbie to white Optical  $\nu=0.211$  branche Corpbie to white Optical  $\nu=0.211$  branches Corpbie to the Dark School Corpbie to the Dark School Corpbie to the Optical Corpbie to the Opt

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## Vivianite Group. Monoclasse

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#### ERTTHRITE. Columb bloom

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#### SCORODITE.

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## Acid Hydrous Phosphates, etc.

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#### PHARMACOLITE

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#### WAVELLITE.

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#### PHARMACOSIDERITE.

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#### CHILDRENITE

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## LIROCOMITE.

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## Uranite Group

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# Phosphates or Arsenates with Carbonates, Suiphates, Borates

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# Oxygen Salts

## 5. BORATES

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#### SUSSEXICE

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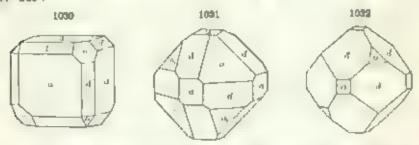
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#### COLEMANITE.

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('leavage a 100) perfect, m 110) less so, b(010) in traces. Fract ire conclusived Rather hattle H = 2-25 G = 159 FT2. Luster vitaods to respons, a normes earthy (or r white, sometimes ground blush or greenish Streak white I translations to opique I see sweetist a ga-

1033 ò MS.

hie fee O to any Ax pt 1 h 010 A = baxa.  $Z \wedge r = 100 = 100$  g = 1447 B = 1470,  $\gamma = 1472$ . 2V = 390

Comp.  $N = R_s(t) = 10H_s(t) \Rightarrow N_{tot}(t) \Rightarrow R_s(t) = R_s(t)$ triox de 50 b, sonta 40 2, water 47.2 = 100

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### ULFXITE Boroug tocarde Na topografica

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### Uranates

GRANINITE, Cleveste Progrente Nevende Pitchillade

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a so the grantes structure sometimes contained, or carved any carr

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Comp. A urum o of urst , gul usums there up or gire it, bt, often the metals of the hinther and but vitinian groups, also continued to grees through heatain and by heat years ig at a rids up to 25 per cont. Chemps and water essent 1" are present in and bount des from des, but only as an impurity. The role on between the larger cargos wilely a line define form, a can be given. R. den was first becovered in it significant and it has been down that and the belong present are produce of the breaking down of the uranum.

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## Oxygen Salts

## 6. SULPHATES, CHROMATES, TELLURATES

A. Anhydrous Sulphates, etc.

The important Barrie Group is the only one among the anhydrous sulphates and chromates.

Massagnite Amazons modulates, (SH<sub>20</sub>SO<sub>2</sub>) Orthorhonds: Usually in crusta in Israhar is furial Converge, (0) distinct H=2 (L=1.76). For , is a water Converge, with with green it. Our risk is  $A_{2}$  and  $A_{3}$  and  $A_{4}$  and  $A_{5}$  are also as a later than the result of the probability begin formed by the nation of scalar and formed and amazonian.

Taylorite. SR 500, Sept. Certification to a supplementary of the section of the s I the At - did Strong theperman, core from the grame of the Charles take to

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Themardite. Na, W). In orthorbombic crystass, pyramalal, short prismatic or to up for also as them by \$100, a late lines electing \$1 = 27 to -238, \$25 s and a = 470, \$2 = 1.457 s 1.454 25 = 83' ( align a least g at 25' ( b) a legalise marked from actions on Often characters in the sale bearing at 25' ( b) a legalise marked from actions on Often characters in the sale bearing at 25' ( b) a legalise marked from actions on Often characters in the sale bearing at 25' ( b) a legalise marked from actions on Often characters in the sale bearing at 25' ( b) a legalise marked from actions on Often characters in the sale bearing at 25' ( b) a legalise marked from actions on Often characters in the sale bearing at 25' ( b) a legalise marked from actions of the Often characters in the sale bearing at 25' ( b) a legalise marked from actions of the Often characters in the sale bearing at 25' ( b) a legalise marked from a legalise ma or he started of Latte III to only in being allots as, before, and at be ground a parties of child the American party to the american in the second of in because, to expect of various and and a structure to A today and a fire towar A plan There are there appears in Macana, to In he to bed States or all new order in the hi Very of central traceman to Cambridge, at the ar Lake San become to the Security a I hadim Marali Migura Co.

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#### GLAUBERITE.

Motochinia. Axes  $a \cdot b : c = 1.2200 - 1 - 1.0275 \quad \beta = 67^{\circ} 40^{\circ}$ 1034

001 ^ 100 = 67 49 St. 001 A 111 = 437 2 Per (0) a s[1 A [1] a mm OR 101 A 150 - 75° 104°

In crystals tab that P ct0011 also prismate Cleavage: c (001 perfect Franture conclusial Brittle H=25 ? G=27 285 Lustry tenthe Color pale verlow or grey sometimes brick red Streak where Taste sugh v salme Open-Ax pl  $= (010 - \lambda \land c \text{ axps} = +30^{\circ} \text{ and}$ as ariv  $\pm$  bases classage.  $2V = 7^{\circ}$   $\alpha = 1.515$   $\beta$ = 1 535 g = 4 536 With rise in temperature 2V

changes rapidly. The nameral becomes uniqual for the D line at 40 6° ( See further p. 325

Comp. NuSO4 CaSO4 = Salphar trioxide 57 6, line 20 1, soda 22 3 =

100; or, Sodium sulphate 51 1, calcium sulphate 48 0 = 100.

Pyr., etc. — B B. decrepitates, turns white, and first at 1.5 to a white coamel, counting the flar se atensely years. Or charge all fusers in the to a clear bend in B F a port in to absorbed by the chargest, here is an infinished opposit restrict. Someten bythock one act I I water it house the transpurency, as partially loss lyed, losving a rest tue of culcular

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tion white, none Streethers, throwers,

# Barrie Group. RSO: Orthorpombic

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Barite	R SO.	75 224	77 431	105° 26′	0.8152	1	-	31.38
Celestite		75 50	78 49"	101 0	0.7700	1	-	2801
Anglesite		76 161	781471	104" 244"	0.7852	1	, I.	25-[14

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# BARITE. Heavy Spar. Baryles.

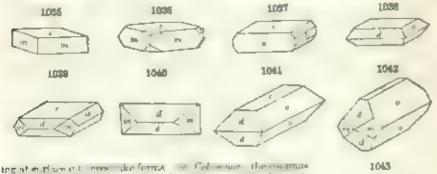
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 det  $05. \land 109 = 127 ?7$  of  $011 \land 305 ?39 565$  or  $01. \land 011 = 71 ?3$  or  $001 \land 011 = 527 487$ . or  $005 \land 111 = 61$ 

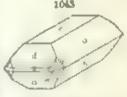
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they age etto) perfect, willio also perfers by 103" the form yielded by cleavage, also biotto superfect. Fracture nevels. Br tie. H = 2.5. 35 G = 43 46 1 ster totro is, it diving to restrictly sometimes pourly on court less that martill Streak white Color wine, also ordining to yellow, gray, blue, rea, or brown, dork brown frausparent to translacent to openue Sometimes fetid, when rubbed Optically + Ax pl b(010) Z = a(100),  $2V = 37^{\circ}$  30',  $\alpha = 1638$ ,  $\beta = 1637$ ,  $\gamma =$ 1.648

Var Indianary of Creature usually here they seemed under the large; again the plumber register. It treated movemen aggregate as of tal and restaut, the cree of project-



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Comp. - Barrum curplate, BaSO, = Sulphur throude 313 baryta 657 = 100

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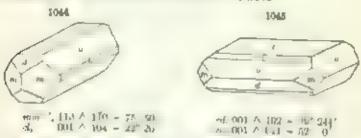
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#### CELESTITE, Contenting

Orthorhanire Axesa  $\delta c = 0.7790 \pm 1.2800$ 



Crystals resembling those of burste in habit—commonly tabel at t < 0.01) or prismatic 1 axis c or t, and note runs y pyramida by the prominence of the forms  $\psi$  (133) or  $\chi$  (144). Also fibrous and radiated, which may abular,

ocean analy granuar

('leaving' c.001) perfect, m(110) nearly perfect, b(010) less distinct Fracture uneven. H = 3.15.  $\ell_1 = 3.95$  1.97. Laster vitrous, sometimes meaning to pearly. Street, white Color white, often faint brush, and sometimes reddish. Transparent to self-translateen. Optionly + Ax. pl., (010) Z 1. (00)  $\alpha = 1.622$ ,  $\beta = 1.624$ ,  $\gamma = 1.631$ ,  $2V = 51^\circ$ . Distinct dispersion,  $\rho < v$ .

Var. 1 Ordinary (a) In crystals of varied habit as noted above, a tinge of a delicate in seas very continuous and announces belongs to one a part of a crystal. The variety from Montanerity, near 1 are, trace quasi apotenes is promote by sees spon of c 011) and doubt, termination to the system of 133 to Fibrone, est, or people is trace and (r Laurinary of tarts occurrence to translar to the extension of tarts occurrence to translar to the extension of tarts occurrence.

Comp. — Strontoum sulphate, SrSO<sub>4</sub> = Sulphur trioxide 43.6, strontos 56.4 = 100. Calcium and barrago are sometimes present.

Pyra, etc. B B (request a lectery stem, fines at 3 to a white poor coroning the flaton etc.) in ref. the function of more remains all projects of the contract fines, and in R for converted by a reflect that the following more results and the contract that the first state of the contract that are not seen as a green and a country red that a Wash with seen but read the before the first a national seen to be contract.

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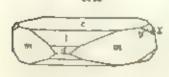
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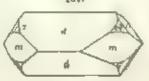
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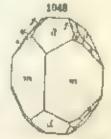
### ANGLESITE.

Orthorhombie: Axes q , b  $c = 0.7852 \pm 1.2894$ 

 $mm^{**}$ ,  $110 \wedge 151 = 76^{\circ} 101^{\circ}$  of,  $001 \wedge 102 = 39^{\circ} 23$  of,  $001 \wedge 011 = 82^{\circ} 12$ 







Crystals sometimes tabular  $\parallel c(001)$ ; more often prismatic in habit and in the three axial directions,  $m_1110_{11}$ ,  $d(102)_{12}$ ,  $d(011)_{13}$  predominating in the

different cases pyramidal of varied types. Also massive, granular to com-

pact, stalactitie; nodular

Cleavage: c(001 m(110) distinct, but interrupted Fracture conclusdid Very britte H = 275-3 G, = 63 630 Laster highly adamantine in some specimens, in others inclining to resmots and vareous. Color white, anged verow gree given, and sometimes he Streak after oped Transparent to proper Option is + to pl + 2 L (100) Duperson strong,  $\rho < \epsilon$  2V = 00 to 75°  $\alpha = 1.577$   $\beta = 1.682$ .  $\gamma =$ 1 894

Comp. Level surpliste, PLSO, - Sulphur trioxide 25.4, lead axide 73.6

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#### ANHYDRITE

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Cleavage in the three pinacoulal directions viewing rectangular fragments but with varying oase, thus, cool very perfect. Lettin also perfect, c 100 semewhat less so Fracture aneven, a net use splinters. Britile. 11 = 3 3 5, Q, = 2.899 2.985. Luster c pent's espect, a er heating in a closed tube; a somewhat areast b vitreous, it massive varieties, vit-

recus incoming to pearly to corwhite, a metimes a graylab 1 call, or red tak tinge, also broke red Streak graved write Optotally + As p case Z  $a = 42^{\circ}$  a = 1.57.  $\beta = 1.570 \quad \gamma = {}^{1}.614$ thet dispersion, p < v

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2 Parathamorphica I' valor der tock and

Comp. Anhydrous calcium suphate, Casa, - Suphar tooxide 58 8, https: 41.2 - 100

Pyr. etc. 1: H free a. I. cohereng he flame reddal on w and colding an mornel was been where reside as near the larges to be as a second was been at least a member of the morne, we at least a member of the morne,

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the eruption of 180%

Manonevichite. Normal ferrie and aleminum sulphase. As a violet incrustation, Alam teresto, latend of Victorio, supari lalanda.

#### CROCOTTE.

Monochure Axes b = 0.9603 - 1.0.9159,  $\beta = 77^{\circ}33'$ 

1002

# 113 A (T) = 60° 50° d. 001 A 11 - 46 58

Crystals causily promute, habit varied. Also imperfectly columnar and granular



Ciencenge of to rather distinct, c 001), a 100, less so fract rescall consideral to uneven Section H + 25-5 G 0.0.1 Insternds rantifie to vitrous. Contyntons shows. of angula hypometric speak charge-yellow. Indestruct the proof  $v + \Delta x p_0$  (01)  $Z \wedge c$  axis  $v + 5^0$   $\alpha = 2 \cdot 1$  $\beta = -37 \ \gamma = 2380 \ 2V = 57$ 

Comp. Leas chromate, PhCrO<sub>4</sub> ≈ Chromano trioxi le 31 1,

lead protoxide 65.9 = 100.

Pyr., etc. In the constitute temperature, I ackept to the year to one and solar or and sag a result of the control le at going a made conting. With salt of procephoral

gives an experient green send o butt flames

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The district of the state of th

her to be the years creation in the most free with their other out burnings. 4 10

# Sulphates with Chlorides, Carbonates, etc. In part hydrous

#### THANHILLIT'S

Monoclinic Axes a  $b \in v = 1.7476 + 1 + 2.2154 + \beta = 80^{\circ} 48^{\circ}$ 

mm 1, 110 4 for - 1201 27 mm\* 1, 110 4 10 ± (201 27 = 100) 4 13 = 88 31 cus, 00) 4 101 = 511 36 = cms, 00) 4 10 = 801 54

Twins tw pl et 1101, analogous to aragouite. Crystole commonly tablehr | c(101)

Cleavage c(001) very perfect, a(100) in traces. Finet ire conchoidal servous beryalin Ruthersectus H = 25. G = 6.25-6.44. Lagueral e pearly, other parts reschous, somewhat adamant ne. Color while passing into yell we green, or gray. Streak ancoured. I ransparent to transport Optically - Ax pl 1 0010  $\lambda \wedge c$  axis = 5°  $\alpha = 187$ ,  $\beta = 240$ .  $\gamma = 2.01 - 2V = 10^6$  Single dispersion, p < 0

Comp. S lightste-ourbenies of and, 4PhO SO, 2004 HaO or PhSO, 2Pht O, Ph OH) = Suphur trioxide 74, carbon di xale 82, sead oxide 82.7

waser 1.7 = .00

Pyr., etc. Il B at mesons, fuses at 10, and turns college but becomes we be on reprint go front red and as charried With man a first in a real water to be done to have come to see a the efter news, and how we write and wante after a management. I while writer

in the closer to se-

Obs. Lea that trian my erid of second any origin I made from broade as the resilt. of the atom or go specimens in It was not been an in a data to be Althorates the artigoral and an one or and least a facility on the man r rentain his field the are set up a trop on a travers of Manual a for the drawn of target may be more type of Research and of the at the target and the start of t to the found at the above to the Man to the Man more dear

of a tree blegge and at on time an other matters a a manifolding with tent to late, but in it in a constant on of that species. From the Squares having Londo do in

Langes we take, Nussia Na F C. Rhombolownal. In racide with a neep physican the real complete H = 5 1 - 20 1 force forthe banks the great is the a white species remaind the us what has been a # 1410 4 = 11° 1 do nome to see I governot his o, presente therefore the At representation to the second to the

Lake our Benear this o California.

Lake our Bernaria to California.

Caractate will all tages, Orthodoreur le secon bayag ou principal.

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letten, etc., and from Asso near Waltenby to Its. wask a control of the action of the second of the from Sangan I such a State to the time to the Law, State a reserve to the state to the following the

dark green mage has been equal to the army which can be a represented or the control of the cont Oh vitterport is his because hide about his a Consession from

An are to distinguish and the Company of the Compan ye w Open ly - a z 1481 + - + tol From Botax cake, a Ber welmo s o .

Chail orner, also from Denser Valley Inyo Co.

# B. Acid and Basic Sulphates

Misanite. Probably used posses a sulphate Hisso. Probably monochair for sides there is not to dot. Five that is California. Zick employee 33' at = 1575, at = 1580, at 1587, at 1587, at 1580, a

### BROCHANTITE.

Orderhander Axes  $a \cdot b \cdot c = 0.7739 + 0.4871$ 

It groups of prisingle telepar creaters may " Liu A 110 = 75° 28") and

drust create massive with restors a structure.

(Throng 600 very perfect, m 150, in traces Pragrammeven H = 354 G = 39 Lieuter success, a litter pearly on the elegange-face broth (clor eta-rild-gran suckets green Sereck paler green Transfor a 1 transfer of 1 (1994) Ax of 180  $\lambda$  : b axis a is 1.728 if = 1.771,  $\gamma$  = 1.800  $2\lambda$  = 7.2 Dispersion  $\rho < \epsilon$ 

Comp. A laser surpostr of copper (480), 30 -Olls, or 4Cuo SO,

311.00 = Sulp our teroxade 17.7, emprie axide 70.3, water 12.0 = 100.

Pyr, etc. Andrewater and at a higher to perut re sol, are son, in the chard to e. and have need us I is flower, and are necessarillands and a copyet With more given

the renotant for many to us

then Dracked to of secureary origin, a log not by the exists sent on each organic therm a the range but and Mangal a morning many I went of white or long and property know was in the seconds who was better night on the believes in The section of the Best of the section of the secti

The angle of the second process of the secon

Large to a compared a compared to the first of the second term of the second term of the second terms of t The second party of the second 
Delerophenate - A beaut cupre and have, ( ), ", In man I brown monor line ever-

talls I vest struct at active of Short

Constitute Al sich plate a les fautes per perhaps I die ( Sel, il.f) Soul of the rate of 17 w 25 s to sell books bearing Color coop s grass to great the great to the color coop s grass to get the great to the color coop s grass to get the great to the color coop s grass to get the great to great the great the great to great the great th . 1 and 21 = 8. A rare - noral of security or gree bond at Reclation . R game a from home a near ly same the are at localistic law ork, Sent and at Red | in the best sed for a same open to a south West him a deprepartable of transfer on a ballon on the Species of season of Absorbed for the later than the season of the later than the later than the season of the later than the season of the later than the la It are in the topic. Mits them has to, New Mexico, beaver for, I call from the Cerro Gordo district, Inju Co., Camaraix.

Linarite A basic sulphate of and and rapper (Pb.Cn.S), (Pb.CnMOTh). In deep blue monor-bile crystals. Cleavages 100 perfect, (00) harnet H = 25. C = 54. From y from the Opticals. As pr = (01) X / c oxis = -24° o = 1 800, 3 = 1 800, 2V = 80° Dispersion, c < v. Linarite occurs in results lead copper decision as a rare mineral of sector any origin. Found at North ass. or Transmissional Street, for a noor Bures sak near Phaterist are, Ural Min. To Sand. a at the mance of the mance of the sector and the mance of the sector and the sector of the se Il was it S bon, etc. Supposed to have been tound farmerly at I water to Proy any Journ, Strong I structed at Land and Landerk, Se and, to a merge of mell sub-order, etc. Change at Teamer near start, South Wat Mr a, at Braken II New South Wales In Alamian. Perhans by the first only 15 on Homesheded H = 23 C = 27 Crystonline

Alamian. Perhana (ala, 250). Hambalioten il alla Sierra Alamagrama, nent la alama, or manusc. White. Opiotoli et se a 588 a = 1 902. Sierra Alamagrama, nent la alama,

Muraia, Spalin.

# C. Normai Hydrous Sulphates

Three well-characterized groups in inclused here. Two of these, the PERSONETE GROUP and the MYLANDERTE Care P. have the same general Orman, RSO, 7H,O, but in the first the crystall nature is or both senter, in the second mon-scame. The species are best known from the artibeal crystals of the laboratory the metave americas are minely crystalized. To emis also the isometric ALLM Choup, to which the same minute is applicable

Lecondite (Na, NR, 20, 20, 21). Orthochambic Primarie denouge H = 25 Very conty funds: Colorless. Optionly = At pl = 001 V = 0 are = 0 = 1450. B = 1452, y = 1453 Prom and grame in the case of Law Predras, control America.

## MIRABULITE. Glatter Sail.

Monocimic Crystala like pyroxene in haldt and angle Usually in

efflorescent crusts.

Cleavage o 100), perfect c 001), b(010) in traces | H = 1.5 2. | G = 1481 I hater vitres as Color witte Transparent to openie. Taste cool, then fee dy saline and bitter. Opticilly - \(\lambda \) pl \(\Lambda \) (7.0) \(Z \lambda \) axis =  $\pm 20^{\circ}$  to  $31^{\circ}$   $\beta = 1.437$  (Or receive allowed proteinal  $\beta = 1.395$ )

Comp. Hydro is sodiom sulpare Naghet 10H2O = Sulpheir transdo

24 8, soda 19 3, water 55 9 = 100

In the closed talks much water gives no intense vellow color to the finms.

Printed In the closed take much water gives not interest serious copie to the name.

Very solution water hopes in a terrangement of the act and take a property of the name of the copies of the name waters in the act as property at the last property. there are an Ohr want he were a fureer a set faller and Hadraght a March ray at at A rouge to Sterna. Manufact vite the accordings of the above to all bars, one in Section Figure Free States, Some West contains. Large e artifice of flatter plants are obtained fact the topoglate Lake til.

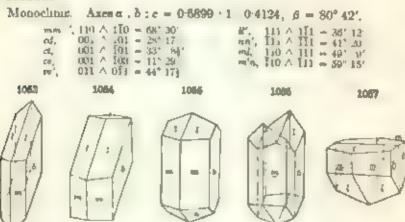
Kinserite. MgM Ha) Musefinde Lie, the missays grateflar to compute See still entry to the limit of the first the first to are large breach, to to be self organished correctly he braids to gette revener a bay any or that heavendon I in Valuat from West, up a point of the classical from I also in Pedicine Co. Sa shorty Contra at Kalone in Code a, compact it. Incompanie to Mayor

major at Istorica, Parpil Szomolnokite, first Hall Manachine beamerphone wit become in parachina O - below open control or branch by any with prince prop a physical part by the man, Commands, Se value of Caramanovalita, Hangary Apparently adente at with jorn parlands

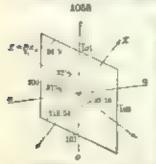
from near Coptago, Chile.

Samilata. MaSO, ByJ Probably memorinae. One cleavage. Stalactitic H. = 1.5. C. = 3.15. Whitish, reddish. Indices, 1.57-1.62. From Felsohanya, (Bala Sprie , Rumania.

#### GYPSUML



Crystals usually simple in habit, common form flattened [ b(010) or priematic to act. For class, again prish atte by extension of a [111]. Also lent equally regign at 1 convex, a nearly at right angles to the vertical axis, edge m(1,0) in [1,0], hence the apparent here is either character of the twin [Fig. 1057]. Supple crystals often with warped as well as carved surfaces. Also feliated massive, lameliar stemate often granular massive, and sometimes maris arguipable. Twins two placeful very common, often the familiar swamow tan twins. X my study of the crystal structure above eight molecules in the unit cell. Each caucium atom her between also copular atomic groups, consisting of four St., terrahedrons and two molecules is of water.



("leavage b.01") comment yielding randy than polished folia o. 100°, giving a surface with conche classification of 111, with a fibrous fracture 1.01° a cleavage fragment has the chombie form of Fig. 1058, with paine angles of 80° and 114° H = 15-2 G = 2.314 2.328, when in pure crystals. Lister of broto pearly and shaing, other faces substitutions. Massive varieties often glastering, sometimes dull earthy. Color usumay white, activitines grave flexis-red honey yellow, bride impure varieties often black, brown, red, or reddish brown. Streak white. Transparent to opaque.

Optically 4. Ax pl. || b (10° and Z \ came = +524° (at 94° C) (cf. Fig. 1058 || Dispersion a > v, as inclined strong 2V = 58°  $\alpha = 1.520$ ,  $\beta = 1.523$  ||  $\gamma = 1.530$  || The optic axial angle increases rapidly with rise of temperature, becoming 0° for the D line at 91° C, see further on p. 325.

War I Practical of it is ready in create transparent in his tigractate or broad from over some for a vite and and and are for a top vaccety from M. at reserving to take the restrict to the factor topic to

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Comp. Hydrons camen supliate, (ast), 2H<sub>2</sub>() = sulphur trocade 46 B. attie 32 5 - Water 2019 - 100

Pur etc. - In the newest the group of materials their risks quest to come at 15.3 colors to the servet of a first toric or care to reterm non the transfer and the second of the

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Licate M. In heart to In house) as horvest aggregation. Color clear green.

Profes Junit Valley Park of Committee

Bianchira - FeSt , Zerste (1884) I rota de monte has i trestalmerrest. While Servera, Itary for ert t armida

# Epsomite Group. 480, 711.0 Orthorhombic

Epsonute	Maso, 7140	a 6 z = 0.0002 [ 0.5700
Consorite	/= > 71EO	0.50507 1 0.5654
Morenosite	Nas-1, 721 Ct	0.981b T 0.9655

### RPSOMITE. Epsom Salt.

Octaor) on bic Spitemental See Fig. 344, p. 145. Usually in heavy adult by the second of one to carries. Streak and coor alste. Ira sparent to translate the butter and salme to early he pl out A = basic A = 1.  $\alpha = 1.433, \quad \beta = 1.485, \quad \gamma = 1.461$ 

Comp. - He is a notice to at phate, MgSO, 7160 - is lighter tracethe Commission P. C. wieter of 2 (100). Second three sooms in sturies of the

copie-home of treats and or mangapase me to ex-

Obs - t is man in a catal materia a fan a criente found if on an efficience of The continue o

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there is the first of the state of the way of the state o are the test of th fixed the steady supreme festiget the later was bound but the Sold, or he t . (); ...

## Melanterite Group. RSO, 7H2O Monochnio

		0:0.6	
Melanterite	FeSO, 7H <sub>2</sub> O	1 1828 , 1 , 1 5427 8	n 75° 44°
Mallardite	MaSO, 7H <sub>2</sub> O		
Pisanite	Argen 80, 7B <sub>2</sub> 0	1609       L5140	74 38
Riebente	Ch8O,7ELO	1 1845 . 1 4 5325	751 207
Capromagnesite	(C), Mg SO, 7H; O		
Boothste	CuSO, 7H <sub>3</sub> O	1 1622 : 1 , 1 500	742 244

The species here included are the ordinary various. They are idented as general fringly with the species of the bosonite group, and are regarded as essentially the same compounds under olar the crystal .. zation

### MELANTERITE. Copperson.

Monochine Usually capillars, filterns strategy, and reserve dears also tangere, pulveraled Converge could perfect of 110 assets for tare topic order and Bratto H = 2 Cl = 180 and Family made. Let tringest taste. Lineary stresses. Coler variets shades I grow posseng hate white, becoming yellow at an example Speak incorrect & Previous parent to the cast cont. I have aweed should be to good, and that are Optically Ax placeton Z A case = 61 a - 1471 d - 1478 7 1 186  $2V = 860^{\circ}$ 

Comp. -- Hy least ferrous suppliede. hestly 711/O se sulph in the same 28 8, in a pre-exide 25 0, water 45:3 = 100. Margarese and unigressing sometimes exposes part of the iron

Obs. . They said use in require from the force specified of a write or past, note wind reall, efforts I were again a grand where a new a trace II a I was against the term of the Server by the tractor above to the line of the control of the line I to that had to a few many by the proper small many and a great or the few many and the great of the state o I without I new count Must be them the Largest he was a literature turber that was a specied

Malarite 31-80,7160 forms more scheres from Local Report 11 to fine Culture 1 form 1 forms and 1 forms and 1 form 1 forms and to the amount can long from the name in dention of page to the page given Zing copper meanterity. Zot on St. Mac in what Zo. 1 ke. 00 is the

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In water bound on a new transaction on the first to

So yets area. A opposite of the literar possesse from the Salvad of time. Question, near College, Ant. also Chile.

By the rise of the literal of the liter

2V nearly 90". Formed by the oridation of cohalt sulphide ores. It is very soleble and therefore of rare ood treme. Found as a recent bemistion in the 4d notes at Burber, Il worn bassin and our where in territors I am Looping a backery America. Cobast-

Should be a set of the to me of the terms as a mineral of welcon lary origin as not Mins synte more least Lemma Bourt a Matthewalt conflicts of art nature next car a new a deversal on, California. Note for the verse of an also can be re Blance, Frances Currents of Mg Scr. 7880 From Venavious

### CHALCANTHITE. Has Valmon

Trichnic  $a,b,c=0.5658-1,0.5507,\alpha=82^{o}\,21',\beta=73^{o}\,11',\gamma=$ 77° 37 | Creatala common y fishtened | p 111) | Occurs also massive stanctitle renders, and domes with fibrous a real pre-

Tenyage M 1 0 , m 110 p 141) imperfect bracture corchoidal. Britis II # 25 G # 242 230 Laster virgous Coor Beran Line to say blue of different ad adea sometimes a little greenish. Stream timesored Subtransparen, to trace usent. I also make to an industria (tip $t_1c_0/y = 21 = 507 \quad a = 1.516 \quad \beta = 1.533 \quad y = 1.546$ 

Comp. Hydrous cupric surplate, (uSO, 5Hr) - Solphar trioxide

32 1 charge exists (1.8, water 36.1 - 100)

Artificial chakan hites have been made in which a partion of the copper has been re-

place to this, is agreed a new as a second

Per, etc. is he seed on a te water and at a higher temperature subshar tel orbite I ask out the fresh with methat as well a year or support. We the course reacts for a gare. We him to water in drug of homes took pasced to a seriface of trop came

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Siderotal bost, that I don white Optional's 2) - rather large, a =

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Limete Mgs has 1,29811 Tetragonal Massive elements. (at \$1 = \$5 t = 14 fact) at let a stephic relies by a section of 1871. (Acuts of believe the section, Section America Reported room a achinosta, Bedienna, Continue value of the one from the sadjeter depoil out this may be the same ma-

terns from both tuston

Heat the tiges  $\lambda \sim 10^{-10}$ , the translation of the primary measurement also manetre graphs of compact M=3 to -2.3 know for a 1 detect to greened, ordered, and Optically -1. At pl. 100. If  $\lambda \in \text{min} = 43^\circ$  and  $\lambda \in \{1,2,3\}$  for  $\lambda \in \{1,2,3\}$  for  $\lambda \in \{1,2,3\}$  for  $\lambda \in \{1,3,3\}$  for  $\lambda \in \{$ 

y = 1-494. 2V = 71° Strong dispersion, p < v. From the salt denosit at Hallstadt lemmingte. Salthurg, Austria at Stanfart, Province of Salthurg and at Leopoldehall in Anitalt from the ent often of Astruation decides to Fuens From the Sait Lange, Pre-ab, India In Antologista, Chic at Intal and Chicromanata in New Mexico at

Batt Lakes, near letter ... lettered to to advise a better take his less than a Leonite Mgst. h.St., tt.) Manager H = 1 (1. = 2.25 have) toolite toloress Options - Ax pt = 0 Z nearly axes a s 1 (83 4 = 148" 7 = 148" 31 - 88 From the salt leposts of Westerngen, Province of Saniny and of

Leonardstan, Anhalt

Bounding white  $\sqrt{12}$ , SO, MgSO,  $\sqrt{13}$ O. Monomine Cleavages. 20) per-et 0 and not H=2 G = 17 Very easily find a 14 parally + Az (H=10) Z + C axis = + 15 + 2 = 14 D, A=14 2 + = 14 D, A=14 7 + 14 D. From the la me are I agreems, functory, Italy Abe, on South Mountain near Santa Pauls, Venture

to. Confirms

Picromerite - MgSO, KeSo, 6HgO As a white cramations currents to Manuclause Cleavings 201 merices II = 2.5 G = 2.1 kennes function on creeks. Operally + Ax pl 000 X A c amp = 145 g = 1400 g = 1400 g = 1447; 23 = 48 From Venus on a st operactionte un accusorphora que un a hair copper replaces the diagnest in the at mount it a scenar and to continue, the une of has my, at Loupelite-Polyhante - Bure Ngou has a Mar Trochur Usuala a retupert fibrous or

Potyments — 21 and 1 Ngra 1 had the first the United to retripent Shrots or temperate masses. Character 100 distance 11 - 2 h 3 1 - 2 h 5 hasts (not as the result of the first of the firs

Bails in or tante. His ordenates and creeks mater and sweet end fine, to treatly - 8 -

1453 I need to be been a first a first and the state of t Co. New Jersey. Amount compete mass services a re- th new with the same servicial exit. B and white in color Comp. Risto, 6R OH , 4B<sub>0</sub>O with R = Mg. Mn. Zn = 5, 3, 4, n = 1,570, n = 1,584, y = 1,585.

## Alum Group. Isometrie

RALSO 1 12HaO or RaSO Ala(SO ), 24HaO KA SON IZERO Potent Alem ONH, AI SO, , 12H<sub>0</sub>O Ammonia Alum, Techermigite NaAl SOca, 12H<sub>2</sub>O Soda Arum

The Alems proper are isometric in crystallization and, chemically, are hydrous suphistes of a minum with an alkali metal and 12 i.e., if the formake to deabled, 24) mu coules of water. The species listed above occur very sparingly in nature, and are best known in artificial form in the laboratory

RACSO, 12H<sub>2</sub>O Isometric Octahedral habit. H = 2 C = 176. Very same fusions our mass a r 45. Aim transact, with the same compaction. Protocoly manuscripts Fibrous Opts of c=Z=b and F = c and r=13 a=1 430 c=1 452  $\gamma=1$  458. 25 very small to 52°. These minerals are often formed by the weathering of schestrate rocks, num-extent which contain your maked printe and bit must no materials, and they may went in cargo answers in such formations. The action of an entire of waters optioning or phone and which has been derived from either some volcame scarce or through the outdation of outdates, show mous containing potential and such as a shorter will also form here. They occur frequently as an off-presence upon any, flavor as numerals. Forms as unnerston with rocean on, etc. as on the Island of Valcases Lapari Isancio, at Vesuvino, at the soliatare at Cape Masses, str., pour Naples.

Found to quarters in various document territory to be department of Aveyron France; in Sports a Will. I take the use of the or peak that a wedness that the name of North we be the contract to America and his for an area sign and In the I are who con was four and quartery at the parties. Microscot. In American at Singer Peak, Estimentally

Techermigate Andrean Lean - All Al St. 1284. Inches Octaheural ful t II = 2 G - 164 hery cases from Company of which we are 148 Met common a new rest a the force of the property to bout one of a re-breit walen at Tablere of the contact that a first a first and the second transfer of the

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Hardrichite Ind. Views Fresh (1 set), (2.11,6) Mande or in vellowed wike Greye room H. 2 ( ) r i e of it is a factor of the same consecution. In the same consecution of the same consecution of the same consecution of the same consecution. Appendix to the same consecution of the same consecutio Property of the there is a second a part of he 4 to May on he Calo River a capital

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nanya (Bais Sprie), Rimmere.

Kornelite. For SO 174R.O Orthorounder Principle Cleavages (400) (010). and # 1 0 the ser a . > fr a rollate and requirelite in the profite Cogn white to we of 1 to event from our message B = 2 C =

21 Familie Conor white, venowish, sewants. Optionary T. w = 1550, a = 1557.

Strong dispersion with abnormal interference colors. From the Larra Amatal a next Cops. approximately a type of the sour to ten to best a see the sound of the sound ete in the first biase has been to be at the longton or in take here for a first at the many the first bear of the

Alunogen a recomplete the action of a sound to be a special and the sound of the sound to be a sound to come to the term of the state of the stat for an five found or many a suppose district begins now on the rise to and for the rings of the plant of the suppose of the su New H of the make the new terms of the life terms to a second and a second to be to a right and a part of the long to a repper to be a few to a

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### Basic Hydrous Sulphates

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#### COPIAPETE.

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Cleavage: c(001) H = 25. G = 2103 Luster pearly Color sufpear-venilly, citron-yellow Transitional Optically + Ax pl X = c axis.  $\alpha = 1.000 \cdot 1.540$ ,  $\beta = 1.528 \cdot 1.56$ ,  $\gamma = 1.575 \cdot 1.500$ 45° to 74°

Comp. - A basic ferric sulphate, perhaps Fe, OH , SO, 15H,O

Many 18 an old term, which has been demonstrat vagued applied. It seems to become in part bure and do just rate is other to steel an arm I a a some as with or no if a

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## Alunite Group

### ALUNTTE. Alcoustone.

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### JAROSETE.

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47 9, potash 9 4, water 13 8 = 100

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A MERITE NAME AND SCALAR OF BUILD Compart White From Almeria,

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Chalcomentia. — CuSeO,  $2H_0O$  In small blue monoclinic crystals.  $H_1=2.5-3$ .  $G_1=3.76$ . Easily fumble. Optimally — Az pi 0— for case is given, git,  $g_1=0.00$  for blue light,  $g_2=1.74$ ,  $g_3=1.74$ ,  $g_4=1.74$ .  $g_4=0.76$  for green light. From the Certo de Cachenta, mear Membras, treentons with after copper schemids. Two reported from Sterra de Umargo and Sucrea Faria and Lin Super Argentina.

M a tracements to bend selectle and Concernments probably colorit mismits, from

the same tocality as chalcomenta-

### Ozygen Salta

### 7. TUNGSTATES, MOLYBDATES

The monoclinic Walframite Group and the tetragonal Scheelite Group are Included here.

### Wolframite Group

Ferberite FeWO.

Wolframite  $(F+Mh)WO_4$  a b c = 0.8255 1:0.8684  $B=89^\circ 32^\circ$ 

Habuerite Mr WO. Ruspite PbWO.

### WOLFRAMITE.

Managinte See above for axes

Twins (1) tw main c with a 100) no comp-face (2) tw pl ki023) Fig. 475, p. 103 Crystals commonly tabular a 1 % also prematic baces in present cone vertically streated. Often blacked lamel-

ar, coarse divergent columns, granular

Cleavage b(1.0) very perfect also parting a(100), and t(102). Fracture uneven Britle H=5.55 G = 7.75 Laster submeta, in Color dark gravish or brownish back. Streak nearly black. Opaque Son e-imes weakly magnetic. Optionary +. Ax p(1.01),  $Z \wedge c$  axis =  $+17^\circ$  to  $21^\circ$ .  $\beta = 2.4c$ , for fertiente, 2.42 for walframite, 2.22 for hubbernte.

Comp. - Tungstate of true and manganese Fe,Mn)

WOL

Forms a series from ferberar FeWO, to habiterite WhWO. It has been suggested that ferberite should melade that portion of the wrest on using up to 30 per end M, WO., hibbnerite the portion containing up to 30 per cent halfold, and welfred to the remaining

Pyre etc. Fusing 8 B masts F = 2.4 to a given in which has a crystolaid interior and is magnetic. The fusing point rates with decrease therefore if the bid selecte mellipsells. With sail of phospheric given with decrease in the fusing selection of the bid on the automated the bid and cooling a given master which contains a time don't be anticipated the bid reflow. With sold and more no pre-rim on times to a bid sixt given marginage. The composed by doing region with an arrange of tangents and as a whole powder. Sufficiently decomposed by experimentary at bid and, in over his bid and appears a character with the said and it will be a proper and a sufficient to give a character such as the contribution of tangents and a reserve to give a character such as the contribution of tangents and it which, treated with metallic rime, becomes the energy blue, but soon forms on the store.

Oha Wolframite is commonly found in grante and pagmatite vains having been formed under predictable architecture. It is very or many association with married to but occurs at times a very attention to the first true free from that are free from that on the interpretation is seen best and president with an physical regards that have been formed under consultance in seen best and president. Often a constitution of pascer deposits.

Some of the more experient here are for its occurrence are as a down from the What Chiles Mis, which of Nerthyrak in Franchishaha, in Bohemas of Czechosovakia at Sching-

genwide and Zarrward in fine creature as it means at Februage a. But Spire in Samply at himself-remove of site in France of the corner, most increase by an at the less Vigits, near to a fine and the first of the site of th

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THE PER ST A NO MAKE

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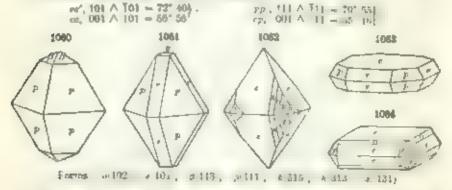
# Scheelite Group Tetragonal-presendel

Scheelite	CaWO <sub>4</sub> p	pp' (111 ∧ Ī11) = 76	0° 551 '	e =	1 5358
Cuprotungstite	C. Bro*				
Caproschoelste	$(C_{2}C_{2})WO_{4}$				
Powellite	$\Theta_{i} W_{i} \oplus W_{i} \oplus W_{i}$	81	L, [,	1 -	1.5445
Stolzite	PiWO.	90	0" 15"	c =	1.5067
Walfenite	$PbMbO_{k}$				1 5771

The Sentences Canter and Jes the tungstates and molyindres of calcula and lead again copper. In crystals rule in the day to the Pyramida Canter of the Tetragonia System. Whatehe is probably temmocrphic.

### SCHKELITE.

Tetragonal-pyratnidal Axis c = 1 5356



Twins 1 tw pl a 100 both contact, and penetral on-twins (Fig. 442, p 188). Habit octahedra also tabular Symmetry shown by faces k, h, a (Fig. 1902 Also renaform with communiar structure massive grandler Cleavage p.111) most distinct, c(101) interrupted. Fracture uneven.

Steetele H = 45-5 (a = 59-81 Expeter vity and itschning to adamsina. Color white relieved write pair versa, from oh greenish, red al. white Irabsparent to transitional tep and w = 1918 1-034

Comp Calcium tangetate, CaWO, a Tangeten tri ande 50 6, lane

19 1 0 100

Machiller in a sample present to begin out! Conjugations repose calcium assembly

politica and Pyra etc. If it in the for era force at 5 to a me, transparent game to a n w to the character was a series of a series of the last of phomphorus forms as glass, some the confirmed and fine or given the confirmed and given the a blue color, later shanging to brown.

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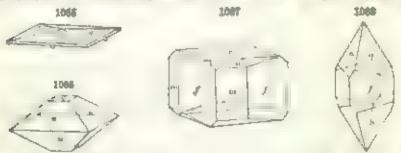
#### WULFERITE.

Tetragonal-pyramidal, benam-rphic Axis c = 1 5771

CO 10.1 A 102 38 1 W 18 4 (1) - 1 W et 8 | 01 1 10 rn, 001 5 11; a 65 h. 88 II - 111 - 80 Zu

Crystals commonly as pare interfer sometimes extremely thin less frequertly as choden, also prove a though as an a material between Auto granular massive, course or fine, firmly cohesive

Cleavage, u(111 very amouth, c(001, a 113) less distinct. Fracture gabeoneheant Brittle H = 275 3 G = 67 70 Lister remices or ad one time. Come wax- to orange vellow siskin- or degree green, yehowetara), aray sh white to nearly concress, he was most ordine to bright red



Streak white. Subtransparent to subtransferent. Optically negative. ness as = 2 502 s. - 3 tol A newslows tours clusterers

Comp. Lead in Vistate, P. Mart, a Moly a count trioxide 30 3, lead exacts (a) 7 = 100. Carer an some since replaces the lead

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Ax pl 4301 A = 5 mas, A = 2 01 From Schneeburg, Samuely

Perrimagetite. Feel, WO, 6HgO. In microscopic heragonal plates. Color page velnow to himsettach yealow. Decomposed by acidir caveing veloca trangetic since. If tickney 10 . - 172 Product of expirition of walframete from Germania Tungaten india,

# VII. SALTS OF ORGANIC ACIDS

### Oxalates, Mollates

Where-filty. — Calcium condata, CaC(O, H/O in small concrete monocitate crystals. Soveral electrogen. II = 2.5 (1) = 2.5 t. Cytom 5 + Az pl. 1 (010). 2 A carin = -20 a = 1 500 x = 1 555, y = 1050 Commonly occurs with carbonaccous materials, in Saxony associates will solut the gir near threaden, as but (which the reliable particular discounts of techniques at the size of the

Oxemente Ammon, in oxemate. All pt-O-2H-O Orthorhombic Soft O = 140. I con failure Weste Opto-ally An you 100 A navie 3 = 140 p = 144, y = 1565, 23 = 42° from the game of the incorpe form is Per-

Hursholdine Hydrone ferrous consiste but a list orthon to treate orientate lines ages, 10 (100 000 ft - 2 to - 25 to -

he the bout Blance a member, law top a manne

Mr ate is to a all a on appears, but all tel at the separal estimate are presented prise and thereof the group per 18 - 5.25 to + 15.165 for honor of the Open then we have produced by the particular of the p Me are a transmit of Irls of the son, from Secondal in Transballatin, Biberia. Reperten from the Judica Breer, Montana.

# VIII. HYDROCARBON COMPOUNDS

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## 3. Oxygenated Hydrocarbons

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# APPENDIX A

# ON THE DRAWING OF CRYSTAL FIGURES

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## DRAWING OF CRYSTALS UPON PROJECTIONS OF THEIR CRYSTAL AXES

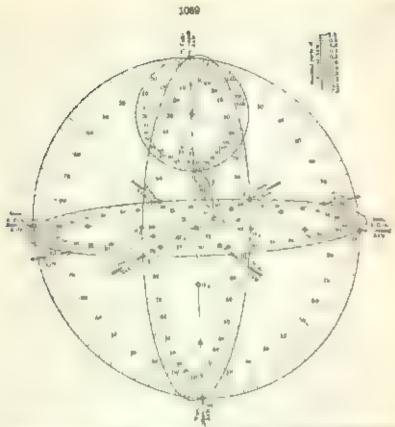
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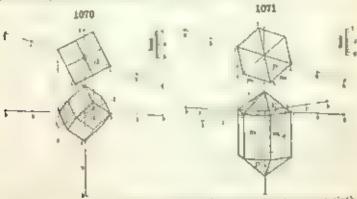
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Fig. 1077 will make out the property play pay which the repetude of the mornel axes are brand. Ing 19 14 to are a bigg his provider of a specificant above of a cube I two past up, one do : " a d as we could protect post, a to ther ABCO, after a reason of 8" to the left a not a vest of back I a note describing three threads it expressed the axes. Fig. 10" aB is buckers an orthograp is projected of a cure to the past on AM Dod A when years from in that the e e or sout diver a being in a leve we the executed. I the past in closer the a passes would of the man face let B ( we strong red that of the front face AB t B that to ag se-

<sup>\*</sup> The yarding Post on Crown to mine appears in may be of to ned from the Minera set car Laterer of the Station Sam to of polar take to very to be tlaven, t appealed to † On Crystal Drawing. Am J 2c., 19, 39, 1965.

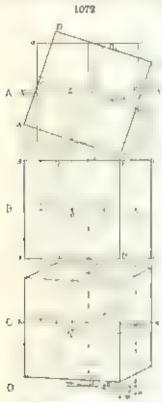


Protractor for plotting crystallographic eves, one-third nature star (after Penfield)



Scheme of the engraved axes of the isometric and hexagonal systems, one-sixth natural site falter l'enficid

per best apast the angle of rever tion to 28. The tangent of which is equal to openhand I am a rank of tiple as at access a sequence of at tank want or to begin in his at 1 his Value to obtain you make it to be that in Value it properties at a rank to the most of the most transfer tiple in the most being from a thought for the great tiple of the angle of



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and cases must be modified. The leaved point apart the cases can be obtained as described above. In the case of the cases the remarks point can be found. I work amount method of construct on. If as is the case in the described charts, a plan of the old reshort-error normalization is given in a tay way, the leavest ength can be tail of directly dipose the nagis in this arthographic projection by decimal of the

the restie is the orthographic projection by distinct of the defended scale and between the projected certain to these distinguishing projection. Or the project distance can be add off on the vert, as also and then by messes if a line travial from the point parameters are puring the extrema see if the south and a sizes of the isometric projection the project of the action of th

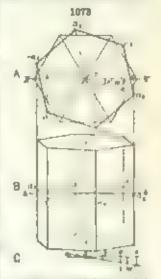
Heragonal System. For projecting the heragonal aximum of the some are arguest and be readly as if no were errors and one are arrangement of the seasonal case. Fig. 10745 in an orthographic, are proved in a pears of a benegative form in two positions, about them in an electrical resolution of 10°20 from what may be readly arranged a time of a finite been proported down as a like borrier toll a time of a horse been proported down as a like borrier of a time of a neglect of which are for are of the time. If it is a neglect of which are for are of the time of the area 

Mounding System. In the case of the monocities are the set since and length of the a arm must be lettered in our case. The west began that it is not set of the arms of the size of the size of the order of the size of the order of the three order of the 
given in this eleps. The gradies of the axis respite determined in a arising ways. The plan of the axis given at the top of the chart may be used for this purpose. Fig. 1974 will instruct the method of proceed are as apposed in the case of orthodose, where it = 64° and it = 0.000.

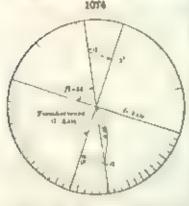
case of arthurbae where it = 64° and a = 0.00. The exculuational ength of the a sign is determined as reason and then this length can be propered upon a by lower ward apon the mellost a main, the discension of which has been provincely accommed as less about above

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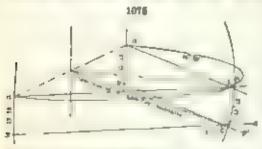
area chart, shows the recovery construction is a color to contain the firection of the beam in the case with possible possible possible of the possible poss



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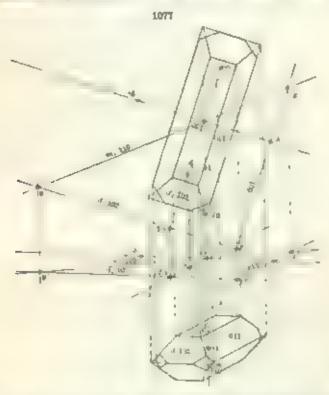
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The forms shown in the figure and the symbols are -lose < 0.001 , prism or  $(110)_s$  brachs done

the or represent a few details of constructions of the orthographic and changing-the propertions shown in Fig. 1076. On the orthographic same the axial lengths a and b are

located the vertical axis closing forms stemed to a point at the center. On the changraphic main, a stored a to the ends of the axis and to are one with the eng personnel main from the termination of the ends o



to 15 on the two sets of same. Since a most projection is made on the plane of the a and be noted the description of all base a characters of the bost operations of a considerable and the a set of the a consections at y and a and a point of the a consections at y and a and a point of the action 
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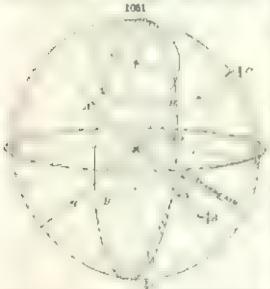
the same from the sector have seen to

the twinning plane, 232. This is above in Fig. 1060 as the triangle from - 3/2e to b to -3/2e. The next step is to find the position of the twin ang area which will be normal to this plane. The conscioustes of this twinning are are given by the \$\phi\$ and \$\rho\$ angles quoted.

above. The point p which p 34" f" leack from the pale to 010 if 6 marks the pases where has norman to the prisin face 230 we of emerge from the sphere. The normal of 252 which is the twinch a nate, will entering on the mendan that rule through the pear pause at such a estable below it ton 1 wil make the angle 10" I. with thoughput we called the mass. Chordeste traver to y from the per is where the a and b axes meet the or ester of the sphero and then chapte parallel to these are brown from the year to a, y and r who were done a one where the die point where the regative end of the laxer wile the epit rival series. The common meeting paint of these charate T marks the days where the was any man pressure the approximation and in a The next seep is so sterpe on the pour cat where the two me measure its he was ing ponen. The metal and a sensation in a right and an to be less unprecising than upof it. Theretitle certifies, later wheel in some or the wife-

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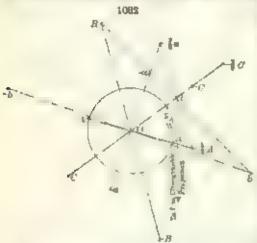
the picture of the two creates the top year fallows at an expensions. I order to the top the construction or exact a farmante of the construction of the state of

sitions. The figure shows dearly the methods of construction on the direction of the area for the two.

I must the two mass found in this was the portion of the crystal in twin position is drawn in exactly the same out, not be not may as the morning post and

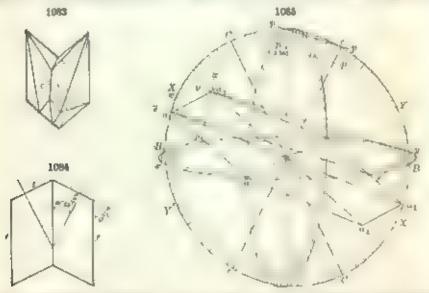
2 To plot the execut the colored to have the process of the case t was desired to represent a semiconhectron twinted pure her to the beauto fitted on the brack that the twinning plane should be vertices and have the position of a city of an orthogen also

crystal. The style from c0001: to 60021 squals 63° 7′ In order to make the face f vertical, the vertical axis a ust be incheed at an angle of 30° 53° or the angle between the class of his two polysimals composing the twin would be double if a or 53° 48°. These



relations we shown it. Fig. 1084 and remed in high 1766 the position of three axes, r and t' in the figure are enally obtained at mornations of 26° 53 by use of the grad at me of the vertical cuttee that presenthrough B and B The puncts t t as f. F. increase the atersections with this same clapse of the awa planes contoo log the on a and a good o their respective unclured positions, the said - BY being in each ruse contal to 26" 83' La order to have the twinting plane now, by a pour no para of to the 013 ms. and an arthurbon be erestate it is necessary to review the name so that one of their beauguant area it it. contracts will be position of the distant of the orthodound a system, as unas in Fig. 1955 The two other heaagreed axes of responding to the axes on at therefore in a a plane which

X' and have such point up that they will make angles of 60° with - as a. The construction accessor to between the ency of towe axes is as four we 1 and the two in the effect of the ency of towe axes is as four we 1 and the two in the effect of the ency of th



cheed that would pass through -B and X. In a similar way draw the two cheeds v a through the second past of points the are 60 fasts;  $u_1$  and  $u_2$  purches v the direction of a cheed that was a pass if rough the pasts B and A. The detections of these two sets of cheeds determine the pasts v and  $v_1$  which are two sources that as the figure connects the ends of the  $u_1$   $u_1$  and  $u_2$  axes that as in A.

plane perpendicular to the ame c. The set of axes that belong to the axis C are to be found is a similar way. The ength of the vertical axis is to be over een in mile it ing that of the tere = 0 and, by there and aring if in the vertical the the length it ar ed to 2 582. This is transferred to the two and c be drawing the tipe p g parallel to the line p-p. The Jearse figure of the culcus two is to be drawn upon these two sels of inclined axis.

# DRAWING CRESTALS BY CAR OF THE SPERSOGRAPHIC AND GRONONIC PROJECT--- NA

The following explanation of the methods of drawing error als from the projections of their forms has been taken with only minus modulentions form Penheid's description."

# I Use of the Street, of Living Profession

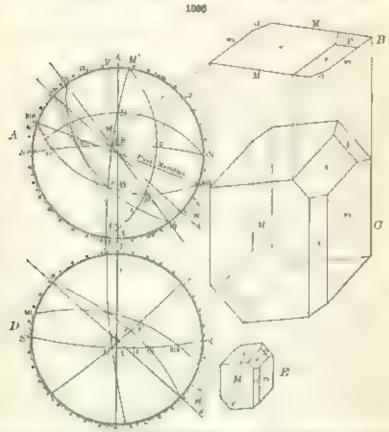
In explaining the method a general example has been chosen, the construction of a drawing of a creata of arcute of the tre - argtern. Fig fresh't represents a stereographic projection of the relinary forms fair to m 1,0 1 1 0 U 110), p(111), r(111 been chosen at 20 trans the horses a tree;

big the Sida pitch, or an one graying properties of as an inter-creetal, so it appears when such as the direction of the vects of and the time of the period of we to m' and, by themes of a 90 triangle, transporting he here than to it as shown by the CONTRACTOR STORY

I'm paretrection of C which may be called a permit perspective view, may text be explained. I is not a in ograph, in pertial, fire the act a read draw to be access. the enthugen on , one . I'm material and the transfer of the surrounding of the surrounding of the transfer of the transfer of the part of the transfer of tere is almost the same of the first and from the property of the first open to at the voice on reshort of armining from arm, we are the eve is removed in its in the crystal farmed in its

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reason for this is not easily comprehended from A, but d it is imagined that the projection is revolved 90° also as a set d d, we as to true Y at the centur the inpuritable poles and great circles to be considered will appear as a Fig. 1087 where P and C are the poles, respectively, of the great circles F > E' and A > A and x is A > f from A at A > f and A > A are the poles, it is evident from the sense of Y > D in A > A and A > A and A > A are equal. Now a basis passing through A > A and A > A and A > A are equal. Now a basis passing through A > A and A > A are equal. Now a basis passing through A > A and A > A extended, which intersect the uphers as a soluble



Development of a plan and para let prespect so by one of any to tripline system. From a stereograph of projection (after Pen and

affects, shown in the figure but since this circle passes through 6, which in Fig. 1086A is the passe of the sters grapher struct that an equal of it is to be projected in Fig. 1086 as a strught one for property of the figure that passes through the point of amount of the reporter will appear on straight have. It has 108 B is occased allows between both A B B is a great error, and B' 40° for the aspect to the passes that great error through B and a post of the figure that a great error little outs B' and a post of the passes of the great error and B' and a post of the figure that a great error little outs B' and a great error that a figure that a great error little outs B' and a great error through B and a figure that a figure of the great or a bit of the great error through the first of the B' and a great error through the great character for the great error the great error through B and a great error through B and a great error through B and a great error through the first product the point of on the graduated circle. By contenting the Penissen transperent great enter protected to Eg. S. p. 55.

at C, and turning it so that W and z fa , on the same great circle, the point z may be trans-

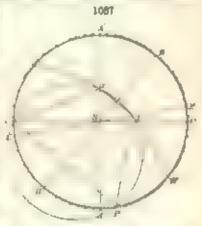
prosed or an lotter peat A is y is a weath he fugge in like insurance

The three being my tratages of responses got to a trace are also discountly starple and them be applied out that a popular of the management effecting in profinctions, in I having on some if a cris is notice is discretely in project, in . If they necessary to draw the greate role SES and to beste one point to ber B' r P to order to the lines. to meeded for a persons ampestive drawing curresponding to Fig. 1 bust. Thus, with only a great code protest of the great total drough the soluted and may be traced,

and a necessarion with and noted an aparent off with as term from a hor Side S. then the great care of during the species as and found n. t B as provided and a sections who to be one a sated, when the negree time in tim two in the same take magnitude and 50° tringgle in arready in another

#### Z. Dilling Str. OF THEN CHYSTALS BY USE OF THE STERBOLDSPILL PROSECTION

In the great may rits of cases the drawing of the result of the state of the paret is tens noticed alternacy the several the forms to the sea as new proces as not then there the months of months see. The proper that if the appeared prespectivel many, brokerier meet a more explanation. As the restrict your plant green being taken from an arta of by hir hape fill to term in an Illipsense, the time of method which the



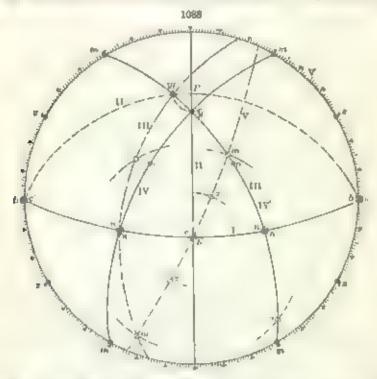
According to the Parson and I to be again the offil face becomes the training plane and as he angle a 2 n = 44° log the angle between a said a two said a term of the contract In this primees of raming the action of the entering to assist in the language to exactly the it has now in equal for face of the train who can got a position within to

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bug 1698 shoung the forms - served on the crystal both in norma, and in twin positions, the force is to an post a series of the distribution technology in the court offer here removed on het on, with the rease is two poet or age drawn is limbed area. Murring set the first the many the two parts of the first for the transpose is no time of the first for the first the many the man

but I to a slong he great it led brough at a \$ 90 and the reach their trapection than the service of the servic voice in , where if the force too their normal positions about the prant P to the crit and through an are 4 90" green take

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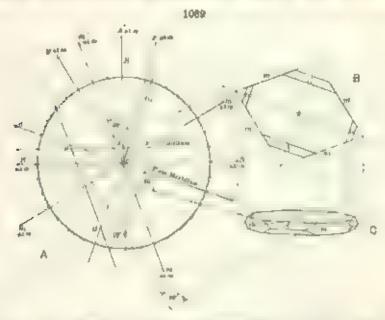
It now be pointed out that I it is wild be livered to show use of the methods of the general artists of the green and assembled below the stereographic projection of the terms plant by rand transference of the green projection by localing the north plant by any of the steres to project on to many pulled by the are of the steres graphic protone too, by 90, p. 50.

#### 3. Use or the Grosomic Profection

As no abstraction, the method of drawing a sample continuation of burits has been chosen. The Group shown in Fig. 1988 are a 101 to 110 to 2.1 and d but. The mention of the power in the generally project on a shown in A, where we are ig 1088 A, the power event in the mass of the form the laser most breather S5. The power of the these most to assert the ment of 5 are in compare tig 1088 A will a the general to prevent at infinity 1 may then made as hig 1089 b. the first time of an integer made is y the case, ag of two forces in it right our sets to a line into ag the power of the faces, shown in figures A and B by the described at 10 to the line property.

The puralle prespective cors, 4800 is an orthographic projection compare Figs. 1066A and C drawn on a plane passing through S and S and intersecting the sphere of

which the gromonic projection is based as a great circle passing through E. Fig. 108015, and frawn parallel to AS the banaron E ban g 10. This great circle is called by a adjustment the Lemma. I made a set interfer into as between a fand a land a sans of figure C note as in Fig. 10804, where the great circles target through the notes of the force intersect the Lemma that he one brough in a not a real, and that through me in I d through disparance to some mand in one of many at g. Next magnes he pearled a rate of many at g. Next magnes he pearled at the sty. It is transposed on an love by making limit to we called Mark Landt H. d Goldschmidt, 40 from a note in Fig. 10804, and as on Fig. 10804, 30° from a point B, which



to an equal matter of excess from E and d. c. given light 10471. Of the three methods given above for the among that to an equation is an experience of the among that the amount of the content of the c

# APPENDIX B

# TABLES USEFUL IN THE DETERMINATION OF MINERALS

This Appendix contains a series of fallow, more of case complete, of or necessarizing second ag to be used as post is or to retain property or ervolutiographs or means abbrackers. These is a believe, will be of service not cuty to the student, but also as

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The tipe wester he reted up of the immeral matter indicates their relative importance. Table I is a complete jet of the species course in his table Larrange I for according to he probabilist bear in marks with bits course a nitrocondo according to not may replicate its real as of Ministella area open or one og a their cowten, of I reads) and on I had be required to come in a complete, I species.

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field, mantioned on p. 301

# TABLE I. MINFRALS ARRANGED ACCORDING TO CHEMICAL COMPOSITION

The following ham nebule as detunted describes, maneral species arranged first according to their in pursont more currents or free unity sector ig to the rine real above in more printed as the annies in represent in as the apprentiate sections.

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Create, Alich. AlicSO<sub>4,4</sub> Alian
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Galante, (Mb, Fe, Mg)O. (Al. FenO)
Galante, (Mb, Fe, Mg)O. (Al. FenO)

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#### CERIUM EARTHS

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Yttrocerte, CaF, with YF,
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Godanite, Ca Mg, Fe Cel CO;
Acceptes, 4Ce i HCO; SecCO, all, O;
Amintoarinte. Rare carths, 4r, carbonate.
Parisite. Ce La Di Fl. CaCO;
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Caryonerite
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Sincerite Th, Ce, Y, Ca, fluo-allicate
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Türnebohmite, Co silicate. Berkelie, Car Ceda, Dr. ShOw Lessagere, Ca,Ce, alle ste Burn to Sounde of race sautha. Helimente (e, et. 11 Mn. (a, abornte Reserve, Sc., etc., storeste Commune, ECaO, Ce, 1, O, CO, 4800, H<sub>2</sub>O Hr thol.te, Ce, etc. of mire and aborphite. Erik is Ce etc affirme and pl sepinate. Techeffenn o, Co. be titano-sheare J hastropire M assudrice Ce, etc., litano-el cates. Rich te Hank street Knopate, Ca.Co. titanato. Lepar te Coa u. a. rianate. Kalhouskite, I. Co.O. I Ti, Knob. Percelagre, Ca,Ce, us sate Chal-vlamprite, R'SonO.F. R'SaO. Reporte Ca.Co monate Pergusunde, 1, Lr Coll, mobale Yttentamante, Fc.(a.), F.c.(c., Antamie Samara, e, Fe,Ca.) Coll mobale Are avade, Ce, asobalisticanate Potyto,grate, Ce,Fe,Ca, ntobaco-tlanate Euxerose 3 Cel niobate-Proyerase titanates. Dienaurandene-Priorite M. Saaran, Ce,La,Di Ph. Photocente Ce Al, p. og hate Radstophur te Hydrona Ce Y phraptuata Churchae, Hydrons Co,Ca, phosphate.

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Resingtonte, Hydrous Cr. suphate,

#### CUBALT

Environne, Co, S., Caroline, CoCo, S., Fe at As, Fig. Cobalanchelpyrite, Co, N., Fe S., Sanaturk Ca Va., Co, N., Fe S., Sanaturk Ca Va., Construct Ca Va., See endere. Co As., Selflance CoAs., Control of Carolin, Ca Fe AsS. Statement Co Fe, 11 D., H.O. He aragenate CoCo Costo, history, Ca, Co, Mg a Ash O., 2Hro. Rossinte, "Ca, Co, Mg a Ash O., 2Hro.

Esymmete, Co.AssOs,8H<sub>2</sub>O Fortesste, Ji, N.Co., AssOs,8H<sub>2</sub>O Jonesste, Hydrous Co-chloro-garate, Haberite, CosO, 7H<sub>1</sub>O.

#### COPPER

Native Copper, Cu. Herstonate Cush. Dorary kite. Cu, Ls. M shows by Conta Agent were, CarAs. Who new to Carlo. Courses to Co. AgS. R. Kar Lie C., I'e. He ar acrite, Caste I mently Capte Ageste. Crockenste. Call relevado Umaniste Cose Capte. block amate Case Permante, at Se 2PhSe, 5 Ni, Co.Se. Chaseocito, Calph Stromeyr to MgCo & Culmente, Caps beds. ( SE ASTR CUS Bornste, Carliera Correct to C . be.Co.S. Carrille Castens, Chalcopyrite, Charles Vendos i to Co Si Co Fe, ou ple le Firehistorgato, the Perish the Market I make to the post of the tell In a margin 2018 Cas 31696. Chilliand to Constant He amo e c, Co V, S 2198 2168. Ista to be Kara it is Her him to 51% 8 och Ships, Bearing to 21% Cups Ships, Sengen to the Car Andle A DO MINE OF BELLY Water to Cuss Bass. the end of the state to sent as ate of to Walls Tetrahedrie, it is \$2.50 kg.
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Bold te, 9PbCl<sub>2</sub>8CuO AgCL9H<sub>4</sub>O. Diamolete, 21% OH a CuCh Chlarax pt to, 2190 Ph ( H & CuCla M tacherlochite, 2NCI CuCia\_HIgO. Cupuite, ( get Tenante, Paramiglacourte, CuO. Confidente Cus Mosta Desirente Curo Feros. Maluchite, Cr. O. U. Offic. Azartta, 26 aCO, CurOL, p Rosante Ce & CC, Ca,Zr OHa, A rabalete, 27 cCa C, 3 Za,Co Ma, V es te Hydraus I, Ca,Ca, varianta De store, He are to CLASSOFT A CUSIO, 2BiO Binomics, Capita, Hgt) Shut nekde 20 uSiO, Hell Planche te. 6C++158004, 2H<sub>2</sub>O. Observe, Cu, Oli Arth. Daline Ph.Cu, Arth. Ph.Cu (OH), Higgs in a Cata Obotati I be for the Chi of El En Calculvollars to, CulCa NO. Ca Ca O L Trans. 16, 30 1 Val. 211.0 Land to, (Cat V)D, 31 (O. Forms a, P. C., classic arrespote. The final to, Ph.C., photomore Cit results, Co. back of a City. France Captures 200 they I'm struc Carballa Cate Presidentials have Carried to early Stans are, 5-t ad a Zu of Apply 211(d) Complian Cally of 10 La Tips to Called Supplied High Reservate, Remark & P. Cu phosphats. Constitute se, (Castava, EagOa) Casta (Cit) Fre more, hit is, Chick Street 24442, n. 1741 Bay losses, il Cu Augo, Ph.Co OH . 100 That to Chatter Carety 21140 (See a subset Carety Caret) 21140 Bartline Water Cutt & Cook all at V archite Hydronia, Collin Calendale. Tangette 2Cat 2Cat Va (1.0) Consens to, Collins 2C (1.1) RO Type of Carlest at a OH . THO Chadwopley has at 400 Angels of the bester te, Hyannas Cu, Su, phosphogrown site. Arabawa to 4Cot 2ZnO Pyth Billion The say Cat April 124 120 Linex by Clash Ast of Cald OH . 2011.0 Cassa rane, 2CoO begin to O. 28(a) Cast state, A for rept to the state of the Hanne sale of A (C), Ly from place, are Cast less to Ly from place, are Cast less to Ly for Ly (Ly 1) (1) 9H4O. Torbornia, Cu 1 (1), 124 (1), 134 (1), 144 (1), 20 merits, Cu 1 (1), 144

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# TABLE II, MINERALS ARRANGED ACCORDING TO THEIR SYSTEM OF CRYSTALLIZATION

#### I CRYSTALLIZATION ISOMETRICS

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<sup>\*</sup>For complete determinative takes based to crystalization see Crystallographic Tables for the Determination of Magnetis by the facility of a 1.25 thouse pseudo-isometric species are here tach and Species with submetable laster are

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# III CRASTALLIZATION HEXAGONAL\* (Bounded-over species are list agained by a retter R

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# IV CRYSTALLIZATION ORTHORHOMSOC

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## V CRYSTALLIZATION MONOCLINIC

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#### B. LISSYER METALIAN AND SUBSETA A.

Wolfenman 72-7-5 5-4-5

#### VI. ORYBIALLIZATION TRICLINIO

#### A. LUSTER NOVEMPALLIC

	Spec 6c Company	Hard- mess		Specific Gravity	Hard- tress
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# TABLE III CRYSTALLINE HABIT

#### 1. ISOMETRIC SYSTEM

In the following late some operate are anumerated whose erystamic liabit is often so marked as to be a cost active coors, by

Cabes Mers. I san obene, Pyric
A shertal. Is re Florite, Conte at times clongated a to capillary forms;
Cernryor to, Harde, bytyste, Borse e Floritances, reite. Mso beny c. For eak a cabe of forms in ar wite the forms of any size to region. Cryotic accessed to with the chambels from species. Chabaste, Alice Cabe to, rarely Quarts. and Henry te

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#### II. TETRAGONAL SYSTEM

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Super tologie evaluate ment with Spagnayl to, Wilderine Tologram

Princip near separate are mitted with a teamber a + x 2 also up and ry 1 pax Ar lab site, Discharge also will be included a favour or 100 floor for

#### IIL HEXAGONAL SYSTEM

Buxagorat Prisms. Sommerable I verus Beryl Aparte. Promordate, bounds wite, Manches anally Liquid Crosseded forms. Also September, March. I seems.

To our time We have Photonesis Diop case are Ages we have Minn, etc. Someth,

Other there against the action of green

May a lackambe or manaches species has ug a progratic arran or about 60' and 12) morale e lan arm belt is simple existence I all thorne as a read of the confi These true we structure to Lord Lie, Corder to It is not to the that the tree is now absent to a first that the arms of a because the other than other the arms of a because of the tree proof.

Tables to a soul or sine are most orth vertex species. Thus, Market Lie even

Gray to, Molecule to, Hammatie Buser to, Cyrelatics Nownerstale Learner Pro-

OTTOME

Heragona Pyramids. Apaiste Cormsom (rhombohedral), Quartz rhombohedral-

traper warnis Hart sire This form to dism smulated by various with chandle of a case is part as the result of the coop for stangels, Mittalian Liveum Chance ite; Stephanite, Polyceate, Jor-Catore, ste. Aur Birekte. W therite; Brombie, Osmanie, Combarita.

Trigonal Prisms. - Tourmaline.

Phombohedrons. Angle "1" and 185" Calvite Deforate, Science Rhodochronte Angle net for run 30" Characte thanto Camte, also Quarte, Hematete. Scalenohodrona. Carcte and adad Carbonasca, Promite.

#### IV ORTHORHOMBIC MONOCLINIC AND TRICLINIC SYSTEMS

Prominette Crystala. Maraille Lucrem Submite, Aramopyrite, Bournopite, Maleganite; t and to at

tite, Dand mee Ale rume ou Pro seue tomple's to Orthodoste Bartle Cletehouse system are the prompt is aspect for an a tree

Tabuar Crystala Lartie Ceruseite Caure Di spore, Williamorte Albuse Merce, Lierza Stabiate, Ramathunto, Miderno, Jame-Acacutar Crystain. contte; Arkinite, and other a evies.

Nonversand It ries for the Naturality Scalerity, Thomson's and other Zookius.

Am Aragon e Steph ander, from they are his many there are

Twin Crystais. The habit of the twom periodical with room approve a very thoraster. into Reference is made to op. 179 to 394 and the accompanying figures for a presentation of this malyect

# TABLE IV STRUCTURE OF MASSIVE MINERALS

Filters accommber. Ashest as amphibose, also the similar ashest form variety

of perjorat in director, to the court of the Courte Company Auto Arapo o to Barne, Commite, A serie, Benesie Emitance, Wolasie ute, Defende Viviante, See and I de mar benesie Wavellie Ferboute, Thomsonie, Satzolite Stabite beolecite.

and over less to etc. A. Maint e.

Co-printer. Mart it I man be to the Hemitite Jamesonite Zichonite, etc. MONMETER I were large to be to the true to tried and their to un more lite, etc., Lyndows, & etc., I summance, withroanne, watering and other Lemmas, Strong-

Lynthite I as of re a lamost stray ture

Inhone at 1 mour rates and the une another Lamellar Sectate Corpore by the To To Terrorymite, Starobergite Foosted. Mercantic Library to, Maytelenste, Tetradymite, Starobergite Nagong to

Micacepta. The Mana p to an the lite Mana p the he Chlorites p 508 Am Remete Organical Tale Torograms, Automote Mana he Chlorites p 508 Am Remete Organical Tale Torograms, Automote Mana adplifies, or design of the Management of Management o

sulpharmer se, etc., he e was e see which are to experience and to companie and topologise.

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Nonversitie Lorenz Malachite Prehinte Smithsonite Calamage, Chalcodony' Brand rately Sphaer to, etc.

Surfaction. Mary taste I write Lamonde Petropeane Mary auth-Saverante Large Cambe, tragente Counte Charedony

Grandar Chavable Mere de l'erra Carria Sousiere à l'eura Carre Le rute, Sphadarite, Fluorite Del ca Carrie, Vragor de Herort de

Barthy Nonwersald Levren Magnesia, Piolite.

# TABLE V. PHYSICAL CHARACTERS

## I CLEAVAGE

Cubic. -- METALLIC LEGIEN Guinna NAMETALARY I COTES II. to Siy tote. The cleavage of Ambrilette also of Cryolite's mundates thus. Cl also Corumium, p. 451

Octahedrat - Fluorite: Dismond Magnetite (a.so Franklimte) has often distinct Octabiestral parting.

Dodocahedral - Sphalerite Asso, imperfect, Sodulite Hauva te.

Rhombobstiral. Carrie and other species of the same group, pp. 551-5211 angles 75° and 105°

Square Prismatic (90" Sea sol to, Ruttle; Kene, me. Prismatic Bartle 783", 1013" Consulte, Ang. solo 54" and 126"), etc. Bana Marty of Instrum Graphs of Midwaler de

A sperature Libertin Applicables Topics Liste he Mican and Chlorites, Chalcophyther, etc. Pare to either shown in Red hazal parring Penacoidal Mercalle Instell Street

A american Lagram Oppoun, Organisat, Euclase, Disspora, Silamande; Lyamte,

Felanjaire

#### II HARDNESS

 Soft Minerals. — The following in normals are compact study Soft that is, H = 2. or lies, her some are a grown for they further the Datas, up at the side Mark of August Complete, Melalie to, Tetranymete Sternbergs c, Argent to:

Nagyagate, some of a n Na an Metala Lond rice.

Sonaterates to rea Tale Evrophy Lie, Broche Tvolle, Orpiment, Cerurge-rite, Canalar, Scipture Cypnan

the Californial Americante is I formy bysterms on photos, phosphates, etc.

2 Hard Minerals Minorma whose hardness to reput to or greater than ? Quarta

The following integrals are here included

#### LEDGER NORMERALLIC

Comments Tell mate The source te If the source te I and come Is not come Is no	7277 - 727 -	Har bergite Zio in a An a toric fin in Lawrence Connecte Connecte Connecte Connecte Fin in the Fin in the College of the Colle	19. 19. 19. 19. 19. 19. 19. 19. 19. 19.
Mela e negate Suppl. rans E-rlesse	7 - 5 7 A 7 B	Dismost	10

The following in negati have harming equal to 0 to 7, or 6.5-7.

Ly syn Mirror. Indontage Irana a Speciality Cassiente Christie. Dingle en Fig. to I-m lote, Forncrite, amountaite, Indette, Parts ante, M. 1. manuta Spodunisoe, Transcrite

#### III SPECIFIC GRAVITY

Attention is called to the remarks in Art. 307 (p. 221), on the original of specific gravity to the ment or make the to the antition in . Art 308 as to the or or special grantey among to merp and meta he and man in trader respectively. The species a carl of the separate stan of Tall a H of immerals constated well even so so to existallisate a are arranged a on g t ascent tip opents graviter. Hence the lasts give at a gallot miderain distinguished by both low and high density

#### IV. LUSTER (See Art. 271, p. 273)

Metallic - Native metals, most Sulphides; some Oxides, those containing from mangazies lead, etc.

Sibmelauc Here belong chiefly certain from and mangatime compounds, as Ilmentic, Ilvare Commiste, Panta te ana alied species, Workmute, Brazante, Rausmunnte.

And How sate. Una true, etc.

Administration. Here belong minerals of high refractive index. (a) Some hard minerals. Discussed Compadant, Casasterie, Zareon, Readle. It Many species of high serving, as ground retr. Cerargyman, Cuprato, some Chambar, etc. co Also certain varieties of Spharer te Transfer and the about te.

Metadic Assuming Pyrargyrite; some varieties of the following. Cuprite, Caras-

gitte, betalieurte Rutile. Rook te

Remount of Wary Schmer to Sulphur Elscolte Serpenting, many Phosphales.

Victorias. Quarts and havy St. aten is formed here ate.

Pearly. The Footest agreement Lake Brazis. Pyrophydice. Also for cleavage surfaces in appendicularly the fill or og A siphy its Stellate. Her hand to. Also, semi-produk-Berte Barros Come to Dangere mine Islanjer, and others Saley. - Some thirous minerals, as syponen Carrie, also Asbratus; Malachite

#### V. COLOR

The following hata may be of some use in the way of suggestion. It is to be noted, howover that each as is it the case of the a principals a sign curface the ground where a effect of const. In a lare, atmosp that rade of the me and auter partie herry, no about he can be drown between course and tax coff re that a many care a se of side in me of pitch case if a seight species. For these responses to listing quality quality extended. count make may cann to completeness.

#### Marause Liberta

Si ver-white, Tin-white - Native Silver; Native Antoniony Armer's and Tellurium, An a gain, Are that he is I bear goo, a veral substance, arectains etc., of robal, of n. Rel, as Collab to reachal some Telbar es, Busanth credibile. No sharp have at be around lar ween the world but for wing grant Street-gray Plant of Marganite Charmente, Spleinlife, Bournous te

Harry at May a me a, she was

Lead gray - Mary suppliers, as takens (blush , Stibuite, many Suppliers tes, etc., nt Junes e Difterny site et

Iron back Uniplie Tetrobolette, Polybaute, Stephanite, Faangie, Pyrohuite,

Man to Hero pe, limber to

Black will a mountain a aster - Burente Limite, Calabrate, Tue alte, etc. W draw e llvate, I rame to et. The co a og are usually brow as black Braunde, Hagemagn te

Copper ted. Ant we comer

Brunze-read Barrice of hity tarmshes give g purplish thirtal; Riccolita.

Brunze-readw - Pyritanite Principles, bre thamptile.

Branze-readw - Chalcopyrite, Militarie turnes, I als firms-yellow: Pyrite; Mar-

Cold relies Nation bend, chalcopyrite as I pyrite sometimes are mutaken for gold. Street. The fellowing informs of metallic custor are notable for the color of that etrenk

Communicated Pyrangyrite.

Cherry ed Mangrite Dud Red Hematite, Cuprite; some Canadar

Sources Committee ununity nonmertall r.

Part Brown Mangan to Emplemente, Chromite

Tellow Latino C. Tarnish. - The following are conspicuous for their height or variegated tarnish. Charcopyrite, Borrite (purposh tipta, Tetrahedrite, some Limmite

#### (b. NOMMETALLIC LUSTER

Coloriest - In Camerata Quarte, Calcite, Aragon to Gypsum, Camerita, Angleste, Albira, Barita, Adularia, Topan, Aja hivi te, Nairia te and other Zeolites. Celest to Diagnora, Neptiente Maiorite Calum ve, Crvel to Phenacite etc.
Massiva Quarte Calite Syptem, Hyabir borr, idal
White. Calcite Angli body treps on Pyrolone dispetde, asually greensl.
Massiva Calcite Miky quarte Feddapura, especially Africa, Cerumite,
Scapento, Taic, Mecanhann, Magnesia: his onte, Ambiygoute etc.

B'ac. - Bacam B z Azarde Crock te Protecture Ladrentite Tearmound Vivinta to

Acture 5. 38 Lary to, Arapto Lapus Las 1, Turquota.

Protection a trapphire, Kyamic, Cordente, Learlie, Chalcanth is and many copper com sounds

Sarsa, in Monkrain-neue Berry, Celemite

VICTORIUS Amethyst Provide

CHEERWED HERE Amason-stone, Chrysocolla Coumtan, Smithauste, some Tubgunta Benya

BLACKIBE GRADE Spidote, Serpm line Pyrozene Amphibole

Fugnano-many Beryl Emerald, Many into, Dividuae, Atacum e and many other Remote Curve See, Chloroc while Tare, Anazen-stone, Prelimite Calabate, See the Calabate, Chloroc while Tare, is

M ATAIN Chiles Bery, accommer to I to use

Arr. remers The Carnet, Chrys pram, Whienite Carner to, Pyrophy ite como Mason de Janeiro a l'Inde-

Рита эпонопава Тумрове

Chavesness Pyrus y Lie, Wavelbie, Variette Chreadery

ORESTON ORDER And about and Pyr arms, that y come has before, Inche breaken to Originalize Boys Aposto, Chayse bory, Chrysolite alter-

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Ormste Stauzzer Legeth at Yorken, then the de-

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Co was a near a metal in rube, to a spend, Placette

Somewhat Commen

But a nan Some Change to red other?

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Pres bisecon Rate to Inter Tegal to Roberto and consiste nome Chabastic Stillate non-Lordand to Aunt, a rarel Ca no. Advanta to Stillate no. Subsection Radio

Brown. Brown figures Some Carnet, some Springerie, Subridge Commenter Eq. rie

COLE-BROWN AT BILL, Zaron Pyromorphie

This wind blown Schools and related arbitrates, Sphalerite, Japet, Lamourte Conethie, Tournalme Vest sanite, Chim not a Sacrutte

B ACKINI BROWN Timuto, some Sciente, Sphalesite. St. KT BROWN CHARLES

Birch I arenal o back Carnet molas to , some Alex especially buttle cansome ample see. Persone and I poste there are mostly greened or treat on the hifurther, some Sphacente and some haids of Charts everying from amone brown to bank ,

also Allimite. Samarskita. Some black morrals with submetable faster are membered

on p 520 Streak — The streak is to be noted in the case of some innersals with noninetallic lister By far the major to have, even were benry owner in the mass of Tournahae, a streak differing by the frait white. The following may be mentioned theorem that we have a Comment and Process to be selected and Process to be selected. Comment and Process to

he switch nan Cape te, Hematite.

Tip own I make be

The streak of this carities copper, green and blue immerals, as Malachite, Assirite, etc., is about the same as the color of the mannel pand, though often a lette paler

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